

**Baseline Soil Investigation
Santa Fe Pacific Gold, Elkhorn Project
Jefferson County, Montana**

COPY

Prepared For:

Santa Fe Pacific Gold Corporation
Albuquerque, New Mexico

Prepared By:

Hydrometrics, Inc.
Consulting Scientists and Engineers

September 1994

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STATE LANDS

BASELINE SOIL INVESTIGATION

ELKHORN PROJECT

JEFFERSON COUNTY, MONTANA

Prepared for:

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September 1994

ANALYTICAL RESULTS FOR WINDHAM SERIES
DATE SAMPLED: 9/21/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	Ap 0 - 7 SFS-9309-226	Bk1 7 - 11 SFS-9309-227	Bk2 11 - 17 SFS-9309-228	Bk3 17 - 60 SFS-9309-229
PARAMETER	UNITS			
pH	6.2	7.7	7.9	8.2
Saturation	39.8	34.3	35.6	28.7
Specific Conductivity	0.40	0.41	0.39	0.58
Calcium	1.90	2.52	2.06	1.00
Magnesium	0.88	0.83	1.18	3.61
Sodium	0.16	0.17	0.27	1.19
Sodium Adsorption Ratio	0.14	0.13	0.21	0.78
Cation Exchange Capacity	36.30	38.81	36.96	28.13
Sand	58	53	44	54
Silt	28	25	30	28
Clay	14	22	26	18
Texture	SL	SCL	L	SL
Very Fine Sand	7.52	6.28	<1	3.08
Rock Fragments	45	55	44	62
Organic Matter	3.0	1.9	1.2	0.3
Nitrate	1.1	<1	<1	<1
Ammonia	1.5	1.3	1.1	1.3
Calcium Carbonate Equivalent	1.3	33.5	40.9	24.4
Neutralization Potential	13	335	409	244
Acid Potential	<1	<1	<1	<1
Acid-Base Potential	13	335	409	244

TEXTURE: S = Sand; SI = Silt; L = Loam; C = Clay

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ANALYTICAL RESULTS FOR WHITECOW SERIES
DATE SAMPLED: 9/21/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A 1 - 3 SFS-9309-242	Bk1 3 - 7 SFS-9309-243	Bk2 7 - 17 SFS-9309-244	Bk3 17 - 30 SFS-9309-245	Bk4 30 - 60 SFS-9309-246
PARAMETER	UNITS	7.5	7.5	7.8	8.1
pH	(s.u.)	7.5	7.5	7.8	8.1
Saturation	(%)	39.6	41.9	34.6	26.9
Specific Conductivity	(mmhos/cm)	0.69	0.82	0.65	0.46
Calcium	(meq/l)	4.92	4.11	2.66	1.45
Magnesium	(meq/l)	2.12	3.75	4.36	2.54
Sodium	(meq/l)	0.08	0.09	0.17	0.19
Sodium Adsorption Ratio		0.04	0.05	0.09	0.13
Cation Exchange Capacity	(meq/100g)	37.32	32.64	13.91	22.74
Sand	(%)	54	56	54	61
Silt	(%)	36	38	39	35
Clay	(%)	10	6	7	4
Texture		SL	SL	SL	SL
Very Fine Sand	(%)	4.12	3.52	1.88	5.20
Rock Fragments	(%)	56	66	74	70
Organic Matter	(%)	3.8	2.4	1.9	0.7
Calcium Carbonate Equivalent	(t/1000t)	73.1	73.3	73.0	69.5
Neutralization Potential	(t/1000t)	731	733	730	695
Acid Potential	(t/1000t)	<1	<1	<1	<1
Acid-Base Potential	(t/1000t)	731	733	730	695

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

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ANALYTICAL RESULTS FOR WARNEKE SERIES
DATE SAMPLED: 9/21/93

HORIZON		A	Bk
INTERVAL (inches)		0 - 2	2 - 12
SAMPLE NUMBER		SFS-9309-239	SFS-9309-240
PARAMETER	UNITS		
pH	(s.u.)	7.2	7.3
Saturation	(%)	47.8	44.5
Specific Conductivity	(mmhos/cm)	0.70	0.65
Calcium	(meq/l)	6.72	5.90
Magnesium	(meq/l)	0.62	0.72
Sodium	(meq/l)	0.14	0.07
Sodium Adsorption Ratio		0.07	0.04
Cation Exchange Capacity	(meq/100g)	60.46	41.73
Sand	(%)	58	50
Silt	(%)	32	34
Clay	(%)	10	16
Texture		SL	L
Very Fine Sand	(%)	7.40	2.12
Rock Fragments	(%)	<2	56
Organic Matter	(%)	10.3	3.1
Calcium Carbonate Equivalent	(%/1000t)	55.6	64.0
Neutralization Potential	(t/1000t)	556	640
Acid Potential	(t/1000t)	<1	<1
Acid-Base Potential	(t/1000t)	556	640

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

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ANALYTICAL RESULTS FOR TROPAL(2) SERIES
DATE SAMPLED: 10/05/93

HORIZON	A	Bk
INTERVAL (inches)	0 - 7	7 - 15
SAMPLE NUMBER	SFS-9309-313	SFS-9309-314
PARAMETER	UNITS	
pH	7.4	7.6
Saturation	45.2	33.1
Specific Conductivity	0.68	0.63
Calcium	5.48	4.84
Magnesium	2.67	2.45
Sodium	0.08	0.10
Sodium Adsorption Ratio	0.04	0.05
Cation Exchange Capacity	50.9	28.4
Sand	58	70
Silt	39	27
Clay	3	3
Texture	SL	SL
Very Fine Sand	2	3
Rock Fragments	52	33
Organic Matter	3.4	2.4
Calcium Carbonate Equivalent	16.1	23.8
Neutralization Potential	161	238
Acid Potential	<1	<1
Acid-Base Potential	161	238

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

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APPENDIX A. LABORATORY ANALYTICAL RESULTS

LIST OF EXHIBITS

- EXHIBIT 1. BASELINE SOIL INVENTORY MAP,
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ELKHORN PROJECT,
JEFFERSON COUNTY, MONTANA MAP POCKET

ANALYTICAL RESULTS FOR TROPAL SERIES
DATE SAMPLED: 10/05/93

HORIZON	A	Bk
INTERVAL (inches)	0 - 4	4 - 15
SAMPLE NUMBER	SFS-9309-311	SFS-9309-312
PARAMETER	UNITS	
pH	(s.u.)	7.5
Saturation	(%)	52.3
Specific Conductivity	(mmhos/cm)	0.54
Calcium	(meq/l)	5.85
Magnesium	(meq/l)	0.52
Sodium	(meq/l)	0.06
Sodium Adsorption Ratio		0.03
Cation Exchange Capacity	(meq/100g)	51.5
Sand	(%)	42
Silt	(%)	45
Clay	(%)	13
Texture		L
Very Fine Sand	(%)	8
Rock Fragments	(%)	62
Organic Matter	(%)	6.7
Calcium Carbonate Equivalent	(%)	29.8
Neutralization Potential	(t/1000t)	298
Acid Potential	(t/1000t)	<1
Acid-Base Potential	(t/1000t)	298

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

BASELINE SOIL INVESTIGATION

ELKHORN PROJECT

JEFFERSON COUNTY, MONTANA

1.0 INTRODUCTION

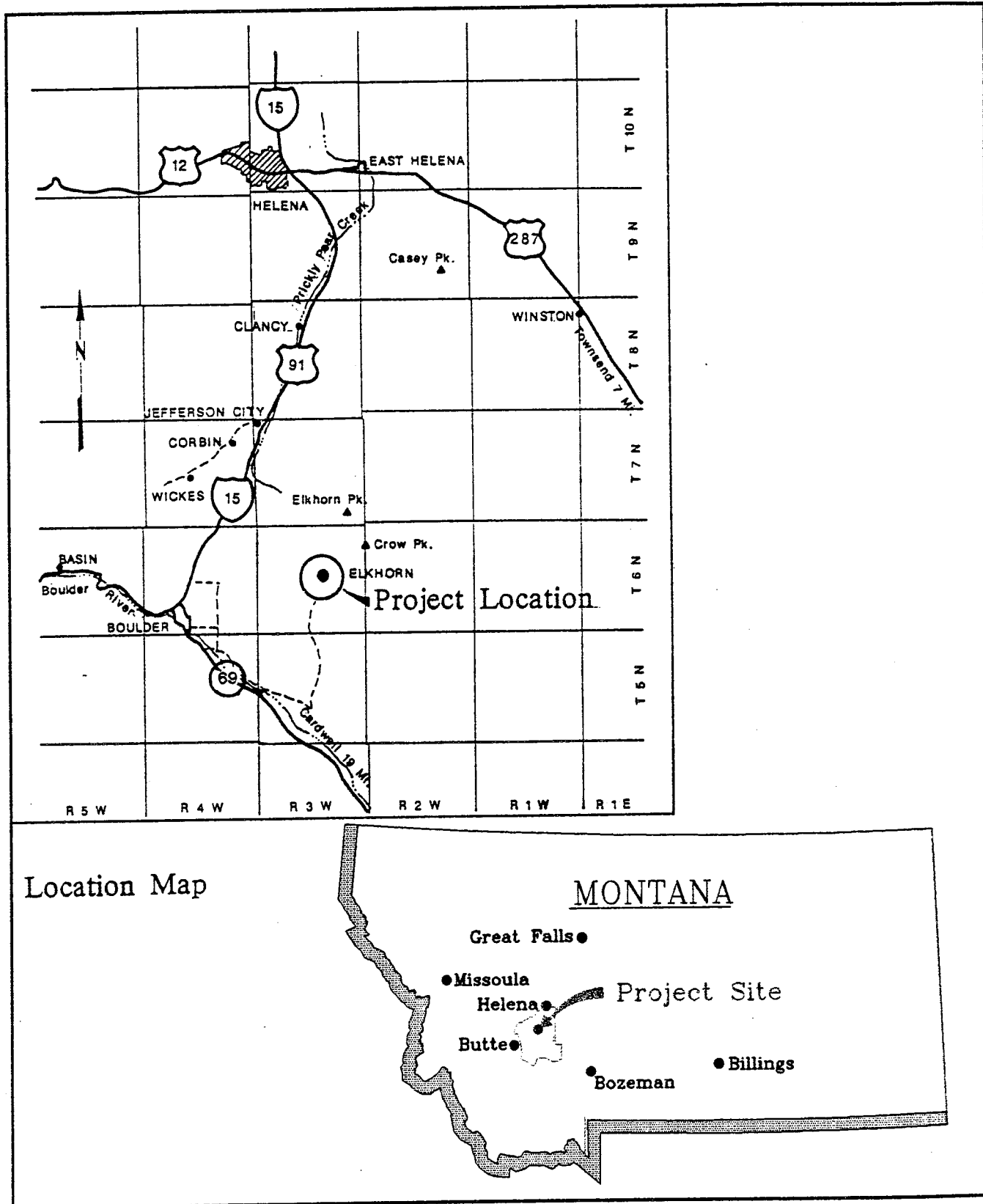
Santa Fe Pacific Gold Corporation (Santa Fe) proposes to develop a gold mine and ore processing facility located in the southern Elkhorn mountains near the Elkhorn townsite in Jefferson County, Montana (Figure 1). The proposed project would be located on patented and unpatented mining claims, U.S. Forest Service, Bureau of Land Management and private lands in Sections 2, 3, 10, 11, 14, 15, 16, 22, 23, 26, 27, 34 and 36, Township 6 North, Range 3 West; and Sections 3, 4, 9, 10 and 11, Township 5 North, Range 3 West.

A detailed baseline soils investigation was conducted to inventory the quality and quantity of soils within the proposed mine project area (Figure 2) that may be salvaged and utilized for reclamation purposes. Soil morphological, chemical and physical data were collected to support an evaluation of construction, reclamation, and land application disposal (LAD) activities based on established Montana Department of State Lands (MDSL) guidelines. During the investigation, every effort was made to give the Elkhorn Project baseline soil inventory continuity with U.S. Soil Conservation Service (SCS) soil survey party work conducted elsewhere in Jefferson County.

ANALYTICAL RESULTS FOR TOLBERT SERIES
DATE SAMPLED: 9/22/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A 0 - 5 SFS-9309-251	Bt 5 - 9 SFS-9309-252	BC 9 - 11 SFS-9309-253
PARAMETER	UNITS		
pH	7.1	7.6	7.5
Saturation	37.7	32.8	49.1
Specific Conductivity	0.90	0.56	0.61
Calcium	7.26	4.45	4.51
Magnesium	1.03	0.61	0.84
Sodium	0.32	0.33	0.34
Sodium Adsorption Ratio	0.16	0.21	0.21
Cation Exchange Capacity	39.73	38.81	41.18
Sand	70	74	64
Silt	26	22	24
Clay	4	4	12
Texture	SL	SL	SL
Very Fine Sand	<1	1.08	<1
Rock Fragments	53	72	53
Organic Matter	3.9	1.7	2.2
Calcium Carbonate Equivalent	1.6	8.6	0.7
Neutralization Potential	16	86	7
Acid Potential	<1	<1	<1
Acid-Base Potential	16	86	7

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay



Proj. No: SFES01
 Dwg. No: 31394H03
 Drawn By: GBH
 Last Update: 9/22/94 GBH
 Ref. Dwg: 31394T

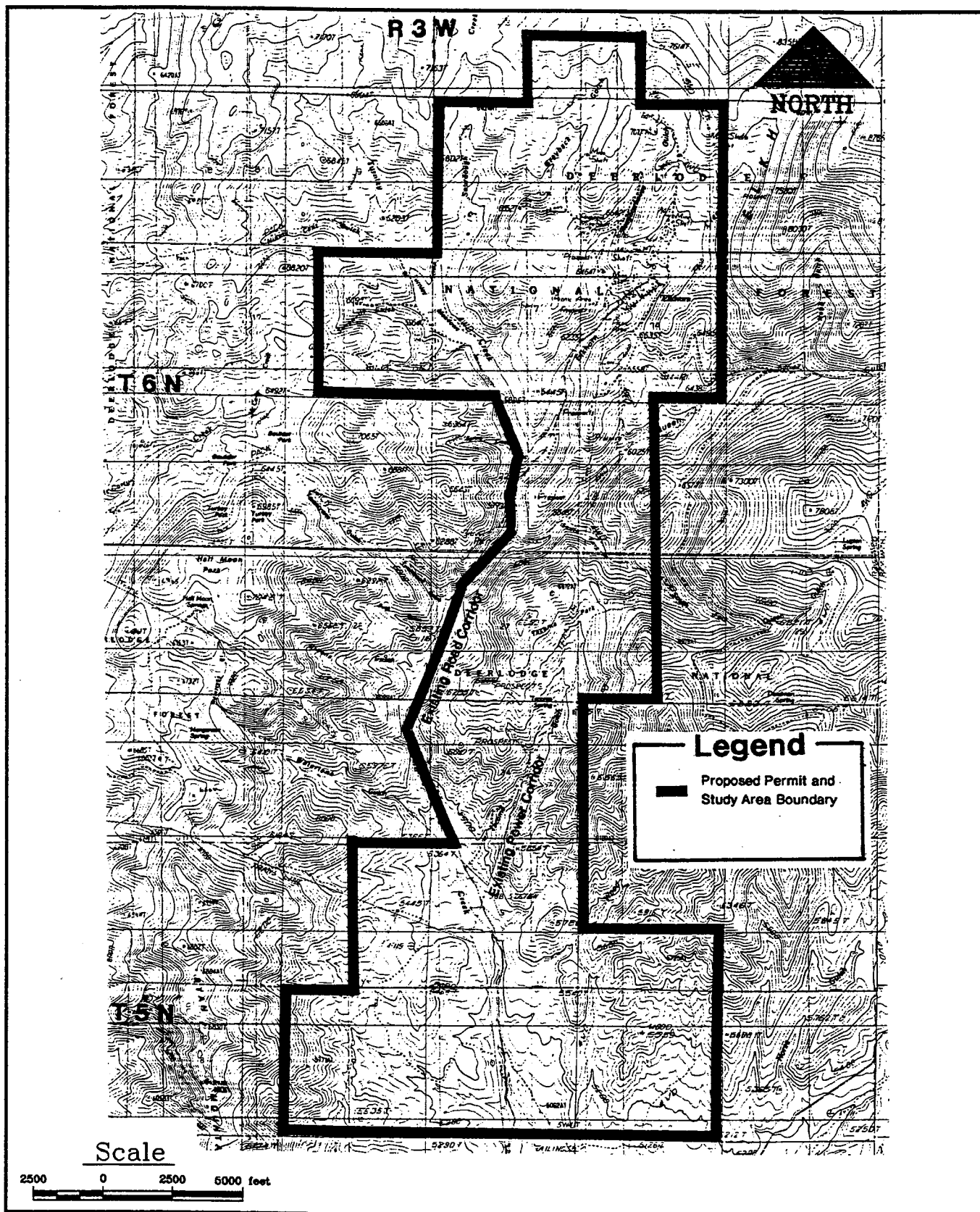
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Figure 1
 Regional Location Map
 Elkhorn Project, Jefferson County, Montana
 Baseline Soil Investigation
 Santa Fe Pacific Gold Corporation

ANALYTICAL RESULTS FOR TIGERON(2) SERIES
DATE SAMPLED: 9/29/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	E1 0 - 2 SFS-9309-276	E2 2 - 8 SFS-9309-277	E/Bt 8 - 13 SFS-9309-278	Bt/E 13 - 22 SFS-9309-279	Bt 22 - 60 SFS-9309-280	2C 60+ SFS-9309-281
PARAMETER	UNITS					
pH	6.1	5.8	5.7	5.8	6.0	6.9
Saturation	66.9	29.6	26.8	25.4	31.1	27.8
Specific Conductivity	0.51	0.27	0.26	0.28	0.20	0.29
Calcium	3.30	1.44	1.50	1.60	1.18	1.28
Magnesium	1.53	0.78	1.02	0.95	0.81	0.80
Sodium	0.18	0.16	0.26	0.34	0.27	0.67
Sodium Adsorption Ratio	0.12	0.15	0.23	0.30	0.27	0.66
Cation Exchange Capacity	44.28	25.09	24.29	27.94	33.33	28.22
Sand	63	55	60	59	52	61
Silt	29	40	35	32	37	30
Clay	8	5	5	9	11	9
Texture	SL	SL	SL	SL	L	SL
Very Fine Sand	24.72	3.92	6.40	6.04	6.46	10.72
Rock Fragments	<2	54	47	43	42	<2
Organic Matter	11.2	1.4	0.9	0.7	0.5	0.3
Nitrate	<1	<1	<1	<1	<1	<1
Ammonia	10.2	10.8	1.8	<1	1.3	1.2
Calcium Carbonate Equivalent	0.7	0.3	0.5	0.7	1.2	0.7
Neutralization Potential	7	3	5	7	12	7
Acid Potential	<1	<1	<1	<1	<1	<1
Acid-Base Potential	7	3	5	7	12	7

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay



Proj. No: SFES01
 Dwg. No: 31394H01
 Drawn By: MAS
 Last Update: 9/22/94 GBH
 Ref. Dwg: 31394T

Hydrometrics, Inc.

Figure 2
 Baseline Soil Inventory Study Area
 Elkhorn Project, Jefferson County, Montana
 Baseline Soil Investigation
 Santa Fe Pacific Gold Corporation

ANALYTICAL RESULTS FOR TIGERON SERIES
DATE SAMPLED: 9/20/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	O 0 - 1	E1 1 - 4	E2 4 - 10	E-Bt 10 - 16	Bt-E 16 - 20	Bt 20 - 42	2C 42 - 60
	SFS-9309-219	SFS-9309-220	SFS-9309-221	SFS-9309-222	SFS-9309-223	SFS-9309-224	SFS-9309-225
PARAMETER	UNITS	5.4	5.8	6.4	6.5	6.3	7.1
pH	(s.u.)	5.4	5.8	6.4	6.5	6.3	7.1
Saturation	(%)	55.7	49.0	35.3	38.0	33.1	38.2
Specific Conductivity	(mmhos/cm)	0.37	0.37	0.59	0.57	0.54	0.37
Calcium	(meq/l)	2.09	1.93	3.44	2.11	3.05	1.62
Magnesium	(meq/l)	0.68	0.60	1.29	0.91	1.41	0.81
Sodium	(meq/l)	0.12	0.29	0.60	0.22	0.32	0.58
Sodium Adsorption Ratio		0.10	0.26	0.39	0.18	0.21	0.53
Cation Exchange Capacity	(meq/100g)	68.39	56.79	33.67	40.65	34.33	51.52
Sand	(%)	50	46	56	48	45	37
Silt	(%)	38	38	30	37	35	37
Clay	(%)	12	16	14	15	20	26
Texture		L	L	SL	L	L	LS
Very Fine Sand	(%)	13.06	6.66	4.46	4.58	6.90	5.26
Rock Fragments	(%)	<2	<2	45	40	45	66
Organic Matter	(%)	12.2	7.6	3.2	2.7	1.7	0.3
Calcium Carbonate Equivalent	(%)	0.5	0.5	0.5	0.5	0.4	0.9
Neutralization Potential	(u/1000t)	5	5	5	5	4	9
Acid Potential	(u/1000t)	1	<1	<1	<1	<1	<1
Acid-Base Potential	(u/1000t)	4	5	5	5	4	9

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

1.1 PREVIOUS INVESTIGATIONS

The SCS has mapped soils in the southern portion of the project area up to the Deerlodge National Forest boundary. The U. S. Forest Service completed a preliminary Level III Land System Inventory (U.S.D.A. 1980) map of the Deerlodge National Forest based on geology, soils and landform. Until the Santa Fe investigation, no detailed mapping of soils on land located in the Deerlodge National Forest within the upper portion of the project area had been conducted. The surficial geology of the Elkhorn Project area has previously been mapped (Klepper et al. 1957 and Everson et al. 1989).

1.2 PROJECT AREA PHYSICAL CHARACTERISTICS

1.2.1 Climate

The elevation of the project area is between 5,000 and 7,800 feet above mean sea level and the climate of the Elkhorn Project area is characterized by long cold winters and short cool summers. The area averages between 20 and 30 inches of precipitation per year and the mean temperature is 38.3 degrees Fahrenheit. The growing season ranges from 60 to 90 days in length.

1.2.2 Geology and Geomorphology

The geology of the Elkhorn Project area is comprised of a folded sequence of sedimentary rocks which have been metamorphosed and altered by igneous intrusions associated with the Boulder Batholith. Igneous rocks in the project area include the Boulder Batholith quartz monzonite, a quartz-feldspar-porphyry (Turnley Ridge Stock), and less extensive, more mafic diorite stocks (Black Butte, East Butte, and Cemetery Ridge). Volcanic rocks in the project area are mostly andesite and are exposed south of the Elkhorn townsite.

Sedimentary rocks which extend over most of the project area are exposed in a north to northeast plunging anticline, the western limb of which has been engulfed by the batholith. Eastern limb sediments dip at approximately 45 degrees. These rocks range in age from late Precambrian to Mississippian and include shale, sandstone, and limestone. Metamorphism has transformed the shale units to argillite and hornfels, sandstone to quartzite, limy shales to calc-silicate hornfels, and limestone to marble. Further local metasomatic alteration of the

ANALYTICAL RESULTS FOR TEPECREEK(2) SERIES
DATE SAMPLED: 10/04/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A 0 - 2 SFS-9309-302	E 2 - 7 SFS-9309-303	Bt 7 - 22 SFS-9309-304	BC 22 - 32 SFS-9309-305	Cr 32 - 52 SFS-9309-306
PARAMETER	UNITS				
pH	5.4	5.4	6.2	6.2	6.4
Saturation	39.7	31.7	17.9	18.0	18.5
Specific Conductivity	0.33	0.30	0.28	0.25	0.25
Calcium	1.88	1.81	1.60	1.38	1.27
Magnesium	0.69	0.65	0.55	0.49	0.42
Sodium	0.21	0.20	0.25	0.16	0.20
Sodium Adsorption Ratio	0.19	0.18	0.24	0.17	0.22
Cation Exchange Capacity	37.0	35.4	21.1	25.0	21.8
Sand	64	60	68	66	78
Silt	29	31	24	23	16
Clay	7	9	8	11	6
Texture	SL	SL	SL	SL	LS
Very Fine Sand	5	4	3	3	7
Rock Fragments	66	<2	51	<2	<2
Organic Matter	4.5	3.3	0.7	0.7	0.5
Calcium Carbonate Equivalent	0.8	0.3	0.4	0.4	0.4
Neutralization Potential	8	3	4	4	4
Acid Potential	<1	<1	<1	<1	<1
Acid-Base Potential	8	3	4	4	4

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

calc-silicate sedimentary rocks (and igneous rocks which intrude them) has produced pyroxene/garnet rich skarn which host ore deposits in the area.

Elkhorn Project area landforms include alluvial fans, stream valleys, gently sloping lowlands, dissected uplands, low hills, glacial valleys, steep mountain slopes and highland rock outcrops. Elevations range from 5,000 feet above sea level in the southern portion of the project area south of the Deerlodge National Forest boundary to 7,800 feet above sea level in the northern part of the project area.

1.2.3 Soils

The development and characteristics of soils in the Elkhorn Project area are a function of many factors including but not limited to temperature, slope, aspect, vegetation and geology. Soil temperature regimes for the project area are cryic, with a mean soil temperature between 32 and 46 degrees Fahrenheit, or frigid, with a mean temperature less than 46 degrees Fahrenheit but with summer temperatures higher than summer temperatures for the cryic regime. Cryic soils in the project area generally occur at elevations greater than 6,000 feet above sea level. Frigid soils generally occur at elevations below 6,000 feet above sea level. The elevation at which frigid and cryic soils occur can vary somewhat depending upon aspect (north, south, east or west exposure).

The majority of the soils in the Elkhorn Project area are classified at the great group level of the U.S Comprehensive Soil Classification System as Cryoborolls, Cryoboralfs, Cryochrepts, Argiborolls, and Ustochrepts. Soils classified as Cryoborolls, Cryoboralfs and Cryochrepts are cold soils that occur in mountainous areas of the project (elevations greater than 6,000 feet above sea level). The vegetative cover on these soils consists of conifers and mixed conifers with some open grassland areas. These soils can be deep (greater than 50 inches to bedrock) or lithic (less than 20 inches to bedrock) and most are skeletal (greater than 30 percent rock fragments in the soil profile). Soils classified as Argiborolls and Ustochrepts are semiarid and occur on more moderate slopes at lower elevations (less than 6,000 feet above sea level). These soils may also be deep or lithic and are also mostly skeletal. The vegetative cover on these soils consists of grassland with scattered conifers.

ANALYTICAL RESULTS FOR TEPECREEK SERIES
DATE SAMPLED: 9/30/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A 0 - 4 SFS-9309-294	E 4 - 14 SFS-9309-295	Bt 14 - 28 SFS-9309-296	BC 28 - 36 SFS-9309-297	Cr 36 - 53 SFS-9309-298
PARAMETER	UNITS				
pH	6.1	6.6	7.2	7.4	7.7
Saturation	41.6	27.3	26.4	25.5	26.4
Specific Conductivity	0.36	0.37	0.39	0.44	0.31
Calcium	1.79	1.37	1.22	1.34	1.74
Magnesium	1.93	1.90	2.62	3.10	1.44
Sodium	0.14	0.30	0.30	0.33	0.12
Sodium Adsorption Ratio	0.10	0.23	0.22	0.22	0.10
Cation Exchange Capacity	32.99	23.65	25.95	24.94	22.21
Sand	60	66	70	70	80
Silt	33	25	23	21	17
Clay	7	9	7	9	3
Texture	SL	SL	SL	SL	LS
Very Fine Sand	6.54	4.88	6.56	7.00	10.48
Rock Fragments	56	62	52	61	<2
Organic Matter	6.8	1.0	0.5	0.3	0.3
Calcium Carbonate Equivalent	0.8	1.0	2.0	1.8	3.1
Neutralization Potential	8	10	20	18	31
Acid Potential	<1	<1	<1	<1	<1
Acid-Base Potential	8	10	20	18	31

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

The surficial geology (parent material) greatly influences the classification and characteristics of project area soils. Soils derived from quartz monzonite or diorite tend to be more coarse textured while soils derived from quartz-feldspar-porphyry, andesite and shale tend to have accumulations of clay (argilic horizons). Soils derived from limestone, calc-silicate hornfels and marble are calcareous (calcic horizons).

ANALYTICAL RESULTS FOR SILAS SERIES
DATE SAMPLED: 10/07/93

HORIZON	A1	A2	C
INTERVAL (inches)	0 - 8	8 - 33	33 - 60
SAMPLE NUMBER	SFS-9309-334	SFS-9309-335	SFS-9309-336
PARAMETER	UNITS		
pH	6.1	6.4	6.4
Saturation	37.4	27.0	24.5
Specific Conductivity	0.34	0.27	0.24
Calcium	2.14	1.27	0.80
Magnesium	0.82	0.51	0.50
Sodium	0.30	0.27	0.16
Sodium Adsorption Ratio	0.25	0.29	0.20
Cation Exchange Capacity	34.6	23.3	19.9
Sand	62	64	59
Silt	29	26	30
Clay	9	10	11
Texture	SL	SL	SL
Very Fine Sand	4	4	2
Rock Fragments	<2	<2	<2
Organic Matter	3.1	1.4	0.7
Nitrate	1.1	<1	<1
Ammonia	1.9	1.3	1.3
Calcium Carbonate Equivalent	0.3	0.2	0.3
Neutralization Potential	3	2	3
Acid Potential	<1	<1	<1
Acid-Base Potential	3	2	3

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

2.0 METHODOLOGY

The Elkhorn Project baseline soil investigation was conducted in accordance with National Cooperative Soil Survey Standards. Reference materials include the National Soils Handbook (Soil Survey Staff 1983), Soil Survey Manual (Soil Survey Staff 1984) and Keys to Soil Taxonomy (Soil Survey Staff 1988). The U. S. Soil Conservation Service field office staff in Whitehall and Helena, Montana provided valuable input and assistance in the development of the Elkhorn Project soil inventory. The SCS assisted with a preliminary soil reconnaissance of the Deerlodge National Forest (northern) portion of the project area. Soil classification reports, mapping unit descriptions, official series descriptions and soil interpretation reports for the soils previously mapped or most likely to be encountered in the project area were obtained from SCS field offices or from the SCS interactive data base (FAST) located in the SCS State Office in Bozeman, Montana.

2.1 SOIL MAPPING

The objective of soil mapping in the project area was to characterize soils in sufficient detail to provide reliable estimates of the volume of soils that could be salvaged once mine plans identify areas to be disturbed. Prior to initiating field survey efforts, field maps of surficial geology were prepared using 1:6000, 40-foot contour interval topographic maps, or if available, 1:6000, 10-foot contour interval orthophotograph maps of the project area. The project area was traversed and soils were described and identified, with their locations noted on field maps. Existing roads provided good access throughout most of the project area to make numerous observations of exposed soil and to establish good relationships between the occurrence of soils and surficial geology (parent material), orientation, slope and vegetation. In addition to existing road cuts, pits were excavated with a backhoe or by hand to expose soils for identification.

After soils were identified and correlated in the field, soil mapping units were delineated on 1:6000 uncontrolled color aerial photographs, and 1:6000, 40-foot contour interval topographic maps. Soil mapping units consist primarily of complexes since soil complexes in the Elkhorn Project area generally contain two or more dominant soil series, so

ANALYTICAL RESULTS FOR SHAWMUT SERIES

DATE SAMPLED: 9/20/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A 0 - 3 SFS-9309-213	Bt1 3 - 7 SFS-9309-214	Bt2 7 - 12 SFS-9309-215	Btk 12 - 15 SFS-9309-216	Bk1 15 - 30 SFS-9309-217	Bk2 30 - 60 SFS-9309-218
PARAMETER	UNITS					
pH	6.9	6.8	6.7	7.6	7.6	7.7
Saturation	31.9	38.7	40.4	41.5	43.1	25.8
Specific Conductivity	0.74	0.53	0.29	0.53	0.36	0.55
Calcium	4.87	3.52	2.08	3.48	2.41	1.34
Magnesium	1.28	0.91	0.49	0.62	0.82	2.69
Sodium	0.53	0.27	0.25	0.23	0.24	1.34
Sodium Adsorption Ratio	0.30	0.18	0.22	0.16	0.19	0.94
Cation Exchange Capacity	38.81	47.04	57.32	49.41	46.25	28.00
Sand	54	58	50	60	64	80
Silt	39	27	31	29	29	17
Clay	7	15	19	11	7	3
Texture	SL	SL	L	SL	SL	LS
Very Fine Sand	<1	4.44	2.26	6.98	3.54	7.14
Rock Fragments	<2	<2	<2	47	41	56
Organic Matter	3.5	2.2	1.6	1.4	1.0	0.2
Calcium Carbonate Equivalent	1.0	0.9	0.9	23.0	29.9	3.2
Neutralization Potential	10	9	9	230	299	32
Acid Potential	<1	<1	<1	<1	<1	<1
Acid-Base Potential	10	8	9	230	299	32

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

intermingled that it is not possible to show each series separately on a map (Exhibit 1). To the extent possible, mapping units used in this investigation were consistent with soil mapping units used by the SCS for mapping soils in similar settings in Jefferson County, Montana. In some cases, mapping units or complexes were developed for the project that contain different combinations or proportions of soil series than previously utilized by SCS to map soils in Jefferson County. However, no soil series were identified in the project area that were not previously included in the SCS Jefferson County soil survey.

A Second Order level of mapping was used in the more accessible areas and areas most likely to be impacted by mining-related activities. Second Order soil delineations varied in size from 0.5 to 10 acres. A Third Order level of mapping was used in the more remote and geologically less complex areas, and in areas least likely to be impacted. Third Order delineations covered areas up to 500 acres in size. Mapping conducted by the SCS within the project area south of the Deerlodge National Forest boundary, and mapping completed by Hydrometrics in the northern portion of the project area was entered into an AutoCAD data base. AutoCAD was used to create soil inventory maps on a 1:6000, 40-foot contour interval topographic base, and to calculate the area of soil mapping units within the project area. A soil inventory map (1:12000) of the Elkhorn Project comprises Exhibit 1. This project area soil inventory is presented on a larger scale (1:6000) in four maps as Exhibit 2.

2.2 DESCRIPTION, SAMPLING AND ANALYSIS OF SOILS

Soils were described and sampled from freshly exposed road cuts or from pits excavated with a backhoe or by hand, depending upon accessibility. Prior to collecting samples from a soil series, the soil profile was described in detail. Information recorded included but was not limited to, thickness, texture, structure, consistency, color, and abundance of coarse fragments and roots for each genetic horizon. In the event a project area soil was mapped but not sampled, the SCS official series description (OSD) was used. Profile descriptions for all project area soils are in Section 3.3 of this soil inventory report.

The objective of soil sampling and analysis was to supplement information in soil profile descriptions and to evaluate the suitability of project area soils for salvage and reclamation

ANALYTICAL RESULTS FOR REDFERN(2) SERIES
DATE SAMPLED: 9/29/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A 0 - 4 SFS-9309-282	E 4 - 9 SFS-9309-282	Bt 9 - 14 SFS-9309-284
PARAMETER	UNITS		
pH	5.8	5.8	6.0
Saturation	58.5	26.4	28.5
Specific Conductivity	0.29	0.24	0.23
Calcium	2.08	1.55	1.51
Magnesium	0.77	0.55	0.57
Sodium	0.08	0.11	0.15
Sodium Adsorption Ratio	0.07	0.11	0.15
Cation Exchange Capacity	53.83	26.81	23.94
Sand	54	68	58
Silt	41	25	39
Clay	5	7	3
Texture	SL	SL	SL
Very Fine Sand	4.72	10.76	6.54
Rock Fragments	<2	55	59
Organic Matter	14.9	1.6	1.2
Calcium Carbonate Equivalent	0.7	0.5	0.4
Neutralization Potential	7	5	4
Acid Potential	<1	<1	<1
Acid-Base Potential	7	5	4

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

or other purposes relative to DSL criteria. Each major soil series in the project area was sampled from at least one location. Soils that occurred more extensively in the project area and most likely to be impacted by mining-related activities were sampled at two locations. Soils of limited areal extent and outside the area that potentially could be disturbed by mining activities were not sampled. Alluvial soils and hydric soils located in active drainage areas were not sampled in order to avoid disturbances (pits) in potential wetland areas. Additional soil sampling can be conducted on a site-specific basis as mine plans are further developed. Soil sampling locations are shown in Exhibits 1 and 2.

A stainless steel trowel was used to obtain 500 to 1000 grams of soil from each horizon. The samples were placed in Ziplock freezer bags and shipped under chain-of-custody to Energy Laboratories, Inc. in Billings, Montana for analysis. The samples were analyzed for the parameters and according to analytical methods specified in Table 2-1. Table 2-1 also shows DSL unsuitability criteria for parameters that were analyzed. Not all parameters analyzed have unsuitability criteria and not all unsuitability criteria are applicable to the Elkhorn Project area soils.

ANALYTICAL RESULTS FOR REDFERN SERIES
DATE SAMPLED: 9/22/93

HORIZON	A	E	Bt
INTERVAL (inches)	0 - 3	3 - 7	7 - 13
SAMPLE NUMBER	SFS-9309-258	SFS-9309-259	SFS-9309-260

PARAMETER	UNITS	6.1	6.0	6.2
pH	(s.u.)	6.1	6.0	6.2
Saturation	(%)	53.0	49.2	49.8
Specific Conductivity	(mmhos/cm)	0.59	0.48	0.40
Calcium	(meq/l)	3.17	2.63	2.54
Magnesium	(meq/l)	1.01	0.78	0.75
Sodium	(meq/l)	0.32	0.26	0.33
Sodium Adsorption Ratio		0.22	0.20	0.26
Cation Exchange Capacity	(meq/100g)	63.12	58.11	57.58
Sand	(%)	34	28	11
Silt	(%)	48	54	58
Clay	(%)	18	18	31
Texture		L	SIL	SiCL
Very Fine Sand	(%)	5.58	3.54	1.00
Rock Fragments	(%)	<2	<2	<2
Organic Matter	(%)	6.6	3.5	1.9
Calcium Carbonate Equivalent	(%)	0.7	0.6	0.6
Neutralization Potential	(V/1000t)	7	6	6
Acid Potential	(V/1000t)	1	1	<1
Acid-Base Potential	(V/1000t)	7	5	5

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

21-Sep-94

TABLE 2-1

BASELINE SOIL INVESTIGATION - SOIL SAMPLING AND ANALYSIS MATRIX, SANTA FE PACIFIC GOLD CORPORATION, ELKHORN PROJECT, JEFFERSON COUNTY, MONTANA

Analytical Parameters	Reference Methods	DSL Unsuitability Criteria
pH	U.S.D.A Handbook No. 60, Method 21a	<4.5; >8.5
EC	U.S.D.A Handbook No. 60, Method 3	>4mmhos/cm
Satn. %	U.S.D.A Handbook No. 60, Method 4	<25%; >90%
OM %	ASA Monograph No. 9, Method 29-3.5.2	<1%
CEC	ASA Monograph No. 9, Method 8-3	NA
SAR	U.S.D.A Handbook No. 60, Methods 2, 3 and 4	>11
Texture:		
% sand	U.S.D.A Handbook No. 18, pp 205-223	<15%
% silt	U.S.D.A Handbook No. 18, pp 205-223	
% clay	U.S.D.A Handbook No. 18, pp 205-223	>35%
% coarse frag.	U.S.D.A Handbook No. 18, pp 205-223	(>2mm) >50% by volume; >66% by weight
CaCO ₃ equiv.	U.S.D.A Handbook No. 60, Method 23C	NA
Acid Potential	R.M. Smith, 1974	
Acid Base Potential	Calculated from acid potential and neutralization potential	<0 tons/1000tons*
**If pH < 5.0:		
Al	SSSA, Vol. 35 No. 4, pp 600-602	2 ppm (pH<5)
As	ASA Monograph No. 9, Method 24-5.1	5 ppm
Zn	SSSA, Vol. 35 No. 4, pp 600-602	70 ppm (pH <6)
Mn	SSSA, Vol. 35 No. 4, pp 600-602	70 ppm (pH <6)
Cu	SSSA, Vol. 35 No. 4, pp 600-602	30 ppm (pH <6)
Pb	SSSA, Vol. 35 No. 4, pp 600-602	140 ppm (pH <5)
Ni	SSSA, Vol. 35 No. 4, pp 600-602	20 ppm (pH <6)
Cd	SSSA, Vol. 35 No. 4, pp 600-602	5 ppm (pH <6)
For Potential LAD Soils:		
NO ₃ -N	ASA Monograph No. 9, Method 33-3.1	
NH ₄ -N	ASA Monograph No. 9, Method 33-3.1	

*Proposed for Elkhorn Project

**As per the work plan, samples are not analyzed for metals if pH is 5 or greater

ANALYTICAL RESULTS FOR NIEMAN SERIES
DATE SAMPLED: 9/22/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A 0 - 4 SFS-9309-254	Bt1 4 - 6 SFS-9309-255	Bt2 6 - 12 SFS-9309-256
PARAMETER	UNITS		
pH	6.6	6.4	6.4
Saturation	38.7	35.7	34.3
Specific Conductivity	0.81	0.66	0.50
Calcium	5.87	4.01	2.48
Magnesium	1.94	1.45	0.99
Sodium	0.45	0.76	1.20
Sodium Adsorption Ratio	0.23	0.46	0.91
Cation Exchange Capacity	40.39	37.49	41.44
Sand	54	52	51
Silt	34	32	33
Clay	12	16	16
Texture	SL	L	L
Very Fine Sand	2.74	1.38	<1
Rock Fragments	<2	<2	<2
Organic Matter	3.6	1.4	0.9
Calcium Carbonate Equivalent	1.1	0.5	0.6
Neutralization Potential	11	5	6
Acid Potential	<1	<1	<1
Acid-Base Potential	11	5	6

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

3.0 SOIL INVENTORY RESULTS

3.1 SOIL MAPPING UNIT LEGEND AND SOIL MAPS

A total of 78 mapping units which covers a total of 8,957 acres and includes 41 soil series were identified in the project area. A soil mapping unit legend for the project area is in Table 3-1 which provides the slope (percent), area (acres), and extent (percent of total project area) of each mapping unit. A soil inventory map of the project area is in Exhibit 1.

Most mapping units identified for the Elkhorn project area (Table 3-1) contain varied proportions of soil series, rock outcrop or rock rubbleland, and inclusions. There may be different phases of a given soil series in a mapping unit based on differences in surface texture or stoniness. Inclusions are small areas of soils which are similar to the dominate series in the mapping units. The composition of each mapping unit, or the percentages of these mapping unit components, is summarized in Table 3-2. These percentages are utilized to estimate the acreages and volumes of soil that may be salvaged. Once mine plans are developed, this information will be required for reclamation plans and soil balance calculations.

3.2 PROJECT AREA SOIL ASSOCIATIONS

An association of soils is considered a landscape with soils occurring in distinctive patterns and proportions. In addition to landscapes, soil associations for the Elkhorn Project soil inventory are organized according to parent material and temperature regime categories. This is done to help users of the inventory better understand when and where specific soil series will occur in the project area. A discussion of soil associations also provides a meaningful summary of the relationships and rationale used to delineate soil mapping units.

3.2.1 Cryic Soils Formed in Colluvium or Residuum From Quartz Monzonite and Diorite

These soils are developed in and are influenced by parent material derived from the Boulder Batholith including diorite (Caseypeak-Bobowic-Franconi association) and quartz monzonite (Caseypeak-Tepecreek-Rock Outcrop association). The temperature regime is cryic (mean

ANALYTICAL RESULTS FOR MARTINDALE SERIES
DATE SAMPLED: 9/20/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	Ap 0 - 3	Bt1 3 - 6	Bt2 6 - 10	Btk 10 - 12	Bk1 12 - 34	Bk2 34 - 50	Bk 50 - 60
	SFS-9309-206	SFS-9309-207	SFS-9309-208	SFS-9309-209	SFS-9309-210	SFS-9309-211	SFS-9309-212
PARAMETER	UNITS						
pH	6.4	6.7	6.8	7.5	8.0	8.6	8.0
Saturation	52.5	38.7	40.9	38.8	38.9	35.2	32.0
Specific Conductivity	0.88	0.50	0.99	0.59	1.75	3.88	8.92
Calcium	4.71	2.00	5.17	3.37	1.58	1.17	4.52
Magnesium	1.57	0.72	1.72	1.11	1.87	2.50	14.10
Sodium	0.25	0.19	0.35	0.46	11.0	30.9	71.7
Sodium Adsorption Ratio	0.14	0.16	0.19	0.31	8.41	22.8	23.5
Cation Exchange Capacity	41.67	36.29	38.29	38.52	35.30	34.53	33.45
Sand	40	56	48	46	34	43	66
Silt	49	32	33	34	38	39	29
Clay	11	12	19	20	28	18	5
Texture	L	SL	L	L	CL	L	SL
Very Fine Sand	7.98	4.90	3.98	1.72	<1	3.84	4.24
Rock Fragments	<2	<2	<2	36	<2	<2	43
Organic Matter	6.1	2.4	1.7	1.7	1.0	0.7	0.3
Nitrate	2.0	<1	<1	1.3	<1	<1	<1
Ammonia	2.8	2.0	1.5	2.2	1.0	1.9	1.1
Calcium Carbonate Equivalent	0.8	0.7	1.5	14.1	26.0	19.1	9.9
Neutralization Potential	8	7	15	141	260	191	99
Acid Potential	1	<1	<1	<1	<1	<1	<1
Acid-Base Potential	8	7	15	141	260	191	99

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

TABLE 3-1 SOIL MAPPING UNIT LEGEND
SANTA FE PACIFIC GOLD CORPORATION, ELKHORN PROJECT, JEFFERSON COUNTY, MONTANA

SYMBOL	MAP UNIT DESCRIPTION	SLOPE (percent)	AREA (acres)	EXTENT (percent)
3	MINES/DUMPS		14.6	0.16
4	USTIC TORRIORTHENTS-TYPIC FLUVAQUENTS	0-8	3.6	0.04
7	MINES/QUARRIES		32.3	0.36
26 C	CRAGO GRAVELLY LOAM	2-8	8.1	0.09
26 D	CRAGO GRAVELLY LOAM	2-8	3.0	0.03
74 D	SHAWMUT GRAVELLY LOAM	4-15	45.4	0.51
92 D	FLUVAQUENTIC HAPLAQUOLLS-TYPIC HAPLOBOROLLS	0-15	191.1	2.15
99 E	LIBEG VERY GRAVELLY LOAM	15-35	7.9	0.09
121 E	MAIDEN-LAP-ROCK OUTCROP COMPLEX	15-35	329.1	3.70
121 F	MAIDEN-LAP-ROCK OUTCROP COMPLEX	35-60	50.8	0.57
122 D	MAIDEN-LAP-WINDHAM COMPLEX	4-15	142.2	1.60
122 E	MAIDEN-LAP-WINDHAM COMPLEX	15-35	57.3	0.65
122 F	MAIDEN-LAP-WINDHAM COMPLEX	35-60	27.6	0.31
123 E	MAIDEN-ROCK OUTCROP-LAP COMPLEX	8-35	91.4	1.03
123 F	MAIDEN-ROCK OUTCROP-LAP COMPLEX	35-60	13.5	0.15
174 D	HANSON-DRYADINE VARIANT COMPLEX	4-15	150.9	1.70
201 E	WINDHAM-ROCK OUTCROP-LAP, VERY STONY COMPLEX	8-35	27.9	0.31
203 D	WINDHAM GRAVELLY LOAM	4-15	47.3	0.53
203 E	WINDHAM, STONY-MAIDEN, VERY STONY-LAP, VERY STONY COMPLEX	15-35	18.3	0.21
204 E	WINDHAM, STONY-MAIDEN, VERY STONY-LAP, VERY STONY COMPLEX	15-35	31.3	0.35
205 E	WINDHAM VERY COBBLY LOAM	4-35	47.3	0.53
206 E	WINDHAM-WINDHAM, STONY COMPLEX	15-35	14.6	0.16
207 E	WINDHAM, STONY-LAP, VERY STONY-ROCK OUTCROP COMPLEX	15-35	56.8	0.64
207 F	WINDHAM, STONY-LAP, VERY STONY-ROCK OUTCROP COMPLEX	35-70	42.1	0.47
209 C	WINDHAM-JUDELL COBBLY LOAMS	2-8	10.9	0.12
263 D	CRAGO-ROCK OUTCROP-PENSORE COMPLEX	4-25	3.3	0.04
265 D	CRAGO GRAVELLY LOAM	4-15	2.3	0.03
274 E	BROWNSHUT	15-45	76.5	0.86
275 A	BROWNSHUT GRAVELLY LOAM	1-4	56.4	0.63
294 C	SIEBEN, STONY-SIEBERELL, VERY STONY COMPLEX	2-15	6.5	0.07
297 F	SIEBEN, RUBBLY-SIEBEN, VERY STONY COMPLEX	15-60	8.5	0.10
325 A	FAIRWAY-NESTLEY CLAY LOAM	0-2	3.2	0.04
581 E	WHITECOW, STONY-WARNEKE, VERY STONY-ROCK OUTCROP COMPLEX	8-35	229.5	2.58
584 F	WHITECOW-WHITECOW, STONY-WARNEKE COMPLEX	25-60	38.5	0.43
585 E	WHITECOW, BOULDERY-SHAWMUT, VERY BOULDERY-ROCK OUTCROP COMPLEX	15-45	128.7	1.45
645 E	VARNEY, STONY-SIEBEN, VERY STONY COMPLEX	15-35	9.8	0.11
731 C	MARTINSDALE, STONY-MARTINSDALE-HIGER COMPLEX	2-8	40.8	0.46
732 D	MARTINSDALE-SHAWMUT, STONY-MARTINSDALE, BOULDERY COMPLEX	4-25	17.0	0.19
742 E	SHAWMUT, STONY-MARTINSDALE, VERY STONY COMPLEX	4-25	137.0	1.54
744 E	SHAWMUT, BOULDERY-SHAWMUT, STONY-TOLBERT, BOULDERY COMPLEX	15-35	503.0	5.66
745 E	SHAWMUT, BOULDERY-SHAWMUT, VERY BOULDERY-TOLBERT, BOULDERY COMPLEX	15-45	63.5	0.71
746 E	SHAWMUT-TOLBERT COMPLEX	8-35	248.2	2.79

ANALYTICAL RESULTS FOR MAIDEN SERIES
DATE SAMPLED: 9/21/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A1 0 - 4 SFS-9309-247	A2 4 - 7 SFS-9309-248	Bk1 7 - 11 SFS-9309-249	Bk2 11 - 26 SFS-9309-250
PARAMETER	UNITS			
pH	7.3	7.2	7.4	7.7
Saturation	39.5	38.2	45.2	35.7
Specific Conductivity	0.52	0.63	0.44	0.44
Calcium	5.58	5.62	3.50	2.10
Magnesium	0.64	0.65	0.62	0.88
Sodium	0.08	0.13	0.33	1.40
Sodium Adsorption Ratio	0.05	0.07	0.23	1.15
Cation Exchange Capacity	40.40	36.92	49.68	16.54
Sand	44	50	28	48
Silt	44	36	56	34
Clay	12	14	16	18
Texture	L	L	SiL	L
Very Fine Sand	<1	<1	3.62	1.96
Rock Fragments	<2	<2	<2	<2
Organic Matter	3.4	2.6	2.4	1.4
Calcium Carbonate Equivalent	50.9	67.0	45.6	69.8
Neutralization Potential	509	670	456	698
Acid Potential	<1	<1	<1	<1
Acid-Base Potential	509	670	456	698

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

TABLE 3-1 (Continued) SOIL MAPPING UNIT LEGEND
SANTA FE PACIFIC GOLD CORPORATION, ELKHORN PROJECT, JEFFERSON COUNTY, MONTANA

SYMBOL	MAP UNIT DESCRIPTION	SLOPE (percent)	AREA (acres)	EXTENT (percent)
943 F	TIGERON, STONY-TIGERON, VERY STONY COMPLEX	25-60	18.1	0.20
944 E	TIGERON, VERY BOULDERY-REDFERN, BOULDERY-ROCK OUTCROP COMPLEX	15-45	952.5	10.72
945 E	TIGERON, VERY BOULDERY-REDFERN, BOULDERY-ROCK OUTCROP COMPLEX	15-45	512.4	5.77
947 F	TIGERON, VERY STONY-REDFERN, RUBBLY-ROCK RUBBLELAND COMPLEX	25-60	32.0	0.36
952 F	REDFERN, BOULDERY-ROCK OUTCROP-TIGERON, VERY BOULDERY COMPLEX	25-60	75.5	0.85
953 F	REDFERN, RUBBLY-ROCK RUBBLELAND COMPLEX	25-60	26.0	0.29
954 F	REDFERN, RUBBLY-ROCK/RUBBLELAND-TIGERON, VERY BOULDERY COMPLEX	35-70	87.4	0.98
992 E	LIBEG, VERY BOULDERY-LIBEG, BOULDERY-NIEMAN, BOULDERY COMPLEX	15-45	2.0	0.02
1103 D	ADEL-LIBEG COMPLEX	4-15	77.0	0.87
1222 C	MARTINSDALE-MARTINSDALE, STONY-SHAWMUT COMPLEX	2-8	83.0	0.93
1222 E	MARTINSDALE-MARTINSDALE, STONY-SHAWMUT COMPLEX	15-35	2.0	0.02
1223 D	MARTINSDALE, STONY-SHAWMUT COMPLEX	2-15	154.0	1.73
1322 D	BEAVERELL, STONY-BEAVERELL, RUBBLY-SIEBERELL, STONY COMPLEX	2-15	7.9	0.09
1341 D	WINDHAM VERY GRAVELLY LOAM COMPLEX	2-15	28.3	0.32
1342 E	WINDHAM-LAP VERY COBBLY LOAM COMPLEX	15-45	62.1	0.70
1343 D	WINDHAM-JUDELL VERY COBBLY LOAM COMPLEX	4-15	27.2	0.31
1563 D	HILGER, RUBBLY-HILGER COMPLEX	8-25	169.2	1.90
1640 D	NIEMAN-ROCK OUTCROP-LIBEG, STONY COMPLEX	2-15	6.8	0.08
1641 E	NIEMAN-ROCK OUTCROP-LIBEG, STONY COMPLEX	15-45	37.6	0.42
1642 F	NIEMAN-ROCK OUTCROP-LIBEG, VERY BOULDERY COMPLEX	25-60	404.1	5.45
1643 E	NIEMAN, STONY-LIBEG COMPLEX	15-35	170.0	1.91
1643 F	NIEMAN, STONY-LIBEG-ROCK OUTCROP COMPLEX	15-35	34.55	0.39
1652 E	SAWBUCK-CLASOIL COMPLEX	8-35	16.5	0.19
1740 E	TROPAL, BOULDERY-HANSON, STONY-ROCK OUTCROP COMPLEX	8-25	94.5	1.06
1742 F	TROPAL-ROCK OUTCROP COMPLEX	25-60	254.4	2.86
1743 E	DRYADINE-TROPAL-ROCK OUTCROP COMPLEX	8-25	225.3	2.54
1743 F	DRYADINE-TROPAL-ROCK OUTCROP COMPLEX	25-60	302.4	3.40
1851 D	SHOOK-SLOCUM-SILAS FAMILY LOAMS	0-8	129.4	1.46
1951 F	FRANCONI-CASEYPEAK, VERY BOULDERY COMPLEX	35-60	125.2	1.41
2090 F	CASEYPEAK, VERY BOULDERY-ROCK RUBBLELAND-FRANCONI, VERY BOULDERY CO	25-60	2.9	0.03
2091 E	CASEYPEAK-ROCK RUBBLELAND-FRANCONI COMPLEX	8-35	38.1	0.43
2484 F	ROCK RUBBLELAND-REDFERN, RUBBLY-HELMVILLE, RUBBLY COMPLEX	35-70	7.9	0.09
2485 F	ROCK RUBBLELAND-REDFERN, RUBBLY-HELMVILLE, RUBBLY COMPLEX	25-70	59.0	0.66
8102 E	TEPECREEK, BOULDERY-CASEYPEAK, VERY BOULDERY-ROCK RUBBLELAND COMPL	8-35	1005.0	11.31
8102 F	TEPECREEK, BOULDERY-CASEYPEAK, VERY BOULDERY-ROCK RUBBLELAND COMPL	35-60	117.7	1.32
8106 E	TEPECREEK, VERY BOULDERY-CASEYPEAK, VERY BOULDERY-ROCK RUBBLELAND, C	15-35	267.2	3.01
8106 F	TEPECREEK, VERY BOULDERY-CASEYPEAK, VERY BOULDERY-ROCK RUBBLELAND, C	35-60	63.3	0.71
8107 F	ROCK RUBBLELAND-CASEYPEAK, VERY BOULDERY COMPLEX	15-60	15.3	0.17
8124 E	BOBOWIC-CASEYPEAK, BOULDERY-ROCK RUBBLELAND COMPLEX	15-25	146.1	1.64
Total			8957.2	100.80

ANALYTICAL RESULTS FOR LIBEG SERIES
DATE SAMPLED: 10/06/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A 0 - 6 SFS-9309-315	BI1 6 - 12 SFS-9309-316	BI2 12 - 20 SFS-9309-317	BI3 20 - 32 SFS-9309-318	BC 32 - 60 SFS-9309-319
PARAMETER	UNITS				
pH	6.7	6.7	6.9	7.4	7.9
Saturation	39.3	30.2	29.9	30.9	26.0
Specific Conductivity	0.33	0.44	0.99	0.77	0.57
Calcium	1.99	2.04	1.74	0.88	0.84
Magnesium	0.87	0.91	2.22	0.56	0.37
Sodium	0.16	1.50	6.50	6.32	5.31
Sodium Adsorption Ratio	0.13	1.24	4.62	7.45	6.83
Cation Exchange Capacity	37.1	26.8	27.3	28.2	30.0
Sand	42	46	47	45	52
Silt	47	45	41	46	41
Clay	11	9	12	9	7
Texture	L	L	L	L	L
Very Fine Sand	5	5	9	7	9
Rock Fragments	52	38	<2	27	<2
Organic Matter	2.9	0.7	0.5	0.5	0.3
Nitrate	1.2	<1	<1	<1	<1
Ammonia	2.1	1.9	1.3	1.5	1.5
Calcium Carbonate Equivalent	0.8	0.7	0.7	1.5	1.8
Neutralization Potential	8	7	7	15	18
Acid Potential	<1	<1	<1	<1	<1
Acid-Base Potential	8	7	7	15	18

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

TABLE 3-2 SOIL MAPPING UNIT COMPOSITION
SANTA FE PACIFIC GOLD CORPORATION, ELKHORN PROJECT, JEFFERSON COUNTY, MONTANA

SYMBOL	SERIES IN MAPPING UNIT	SLOPE (percent)	PERCENT OF MAPPING UNIT	SYMBOL	SERIES IN MAPPING UNIT	SLOPE (percent)	PERCENT OF MAPPING UNIT
3	MINES/DUMPS		100	174 D	HANSON DRYADINE VARIANT INCLUSIONS	4-15 4-15	50 30 20
4	USTIC TORRIORTHENTS TYPIC FLUVAQUENTS INCLUSIONS	0-8 0-1	40 40 20	201 E	WINDHAM ROCK OUTCROP LAP, VERY STONY INCLUSIONS	8-35 8-35	30 20 15 35
7	MINES/QUARRIES		100	203 D	WINDHAM GRAVELLY LOAM INCLUSIONS	4-15	85 15
26 C	CRAGO GRAVELLY LOAM INCLUSIONS	2-8	90 10	203 E	WINDHAM GRAVELLY LOAM INCLUSIONS	15-35	85 15
26 D	CRAGO GRAVELLY LOAM INCLUSIONS	2-8	90 10	204 E	WINDHAM, STONY MAIDEN, VERY STONY LAP, VERY STONY INCLUSIONS	15-35 15-35 15-35	40 20 20 20
74 D	SHAWMUT GRAVELLY LOAM INCLUSIONS	4-15	85 15	205 E	WINDHAM VERY COBBLY LOAM INCLUSIONS	4-35	85 15
92 D	FLUVAQUENTIC HAPLAQUOLLS CUMULIC HAPLAQUOLLS TYPIC HAPLOBOROLLS INCLUSIONS	0-4 0-2 0-15	40 30 20 10	206 E	WINDHAM WINDHAM, STONY INCLUSIONS	15-35 15-35	60 30 10
99 E	LIBEG VERY GRAVELLY LOAM INCLUSIONS	15-35	85 15	207 E	WINDHAM, STONY LAP, VERY STONY ROCK OUTCROP INCLUSIONS	15-35 15-35	45 25 20 10
121 E	MAIDEN LAP ROCK OUTCROP INCLUSIONS	15-35 15-35	45 30 20 5	207 F	WINDHAM, STONY LAP, VERY STONY ROCK OUTCROP INCLUSIONS	35-70 35-70	35 25 25 15
121 F	MAIDEN LAP ROCK OUTCROP INCLUSIONS	35-60 35-60	40 30 25 5	209 C	WINDHAM COBBLY LOAM JUDELL COBBLY LOAM INCLUSIONS	2-8 2-8	60 25 15
122 D	MAIDEN LAP WINDHAM INCLUSIONS	4-15 4-15 4-15	40 25 20 15	263 D	CRAGO ROCK OUTCROP PENSORE INCLUSIONS	4-15 4-25	30 25 25 20
122 E	MAIDEN LAP WINDHAM INCLUSIONS	15-35 15-35 15-35	35 30 15 20	265 D	CRAGO GRAVELLY LOAM INCLUSIONS	4-15	90 10
122 F	MAIDEN LAP WINDHAM INCLUSIONS	35-60 35-60 35-60	40 30 15 15	274 E	BROWNSHUT GRVL BROWNSHUT CBVL BROWNSHUT, VERY STONY INCLUSIONS	15-45 15-45 15-45	40 30 20 10
123 E	MAIDEN ROCK OUTCROP LAP INCLUSIONS	8-15 8-35	45 20 15 20	275 A	BROWNSHUT GRAVELLY LOAM INCLUSIONS	1-4	90 10
123 F	MAIDEN ROCK OUTCROP LAP INCLUSIONS	35-60 35-60	40 25 20 15	294 C	SIEBEN, STONY SIEBERELL, VERY STONY INCLUSIONS	2-15 2-15	50 35 15

ANALYTICAL RESULTS FOR LAP SERIES
DATE SAMPLED: 9/21/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A 0 - 5 SFS-9309-230	Bk1 5 - 9 SFS-9309-231	Bk2 9 - 19 SFS-9309-232
PARAMETER	UNITS		
pH	6.8	7.5	7.8
Saturation	33.8	47.5	52.9
Specific Conductivity	1.31	0.50	0.33
Calcium	8.08	3.80	2.20
Magnesium	2.42	0.84	1.29
Sodium	0.20	0.19	0.23
Sodium Adsorption Ratio	0.09	0.12	0.17
Cation Exchange Capacity	37.99	44.01	38.93
Sand	60	37	19
Silt	30	47	57
Clay	10	16	24
Texture	SL	L	SIL
Very Fine Sand	3.16	5.58	<1
Rock Fragments	60	<2	<2
Organic Matter	2.2	2.4	1.7
Nitrate	<1	1.4	1.2
Ammonia	5.0	3.2	2.5
Calcium Carbonate Equivalent	3.3	29.7	34.3
Neutralization Potential	33	297	343
Acid Potential	<1	1	<1
Acid-Base Potential	32	296	343

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

TABLE 3-2 SOIL MAPPING UNIT COMPOSITION
(Continued) SANTA FE PACIFIC GOLD CORPORATION, ELKHORN PROJECT, JEFFERSON COUNTY, MONTANA

SYMBOL	SERIES IN MAPPING UNIT	SLOPE (percent)	PERCENT OF MAPPING UNIT	SYMBOL	SERIES IN MAPPING UNIT	SLOPE (percent)	PERCENT OF MAPPING UNIT
257 F	SIEBEN, RUBBLY SIEBEN, VERY STONY INCLUSIONS	15-60 15-60	55 35 10	943 F	TIGERON, STONY TIGERON, VERY STONY INCLUSIONS	25-60 25-60	60 30 10
325 A	FAIRWAY CLAY LOAM NESTLEY CLAY LOAM INCLUSIONS	0-2 0-2	60 30 10	944 E	TIGERON, VERY BOULDERY REDFERN, BOULDERY ROCK OUTCROP INCLUSIONS	15-45 15-45	55 20 15 10
581 E	WHITECOW, STONY WARNEKE, VERY STONY ROCK OUTCROP INCLUSIONS	8-35 8-35	35 30 15 20	945 E	TIGERON, VERY BOULDERY REDFERN, BOULDERY ROCK OUTCROP INCLUSIONS	15-45 15-45	50 25 15 10
584 F	WHITECOW WHITECOW, STONY WARNEKE INCLUSIONS	25-60 25-60 25-60	50 25 15 10	947 F	TIGERON, VERY STONY REDFERN, RUBBLY ROCK RUBBLELAND INCLUSIONS	25-60 25-60	45 30 20 5
585 E	WHITECOW, BOULDERY SHAWMUT, VERY BOULDERY ROCK OUTCROP INCLUSIONS	15-45 15-45	45 25 15 15	952 F	REDFERN, BOULDERY ROCK OUTCROP TIGERON, VERY BOULDERY INCLUSIONS	25-60 25-60	40 25 25 10
645 E	VARNEY, STONY SIEBEN, VERY STONY INCLUSIONS	15-35 15-35	60 30 10	953 F	REDFERN, RUBBLY ROCK RUBBLELAND INCLUSIONS	25-60	50 30 20
731 C	MARTINSDALE, STONY MARTINSDALE HILGER INCLUSIONS	2-8 2-8 2-8	35 25 25 15	954 F	REDFERN, RUBBLY ROCK RUBBLELAND TIGERON, VERY BOULDERY INCLUSIONS	35-70 35-70	40 25 20 15
732 D	MARTINSDALE SHAWMUT, STONY MARTINSDALE, BOULDERY INCLUSIONS	4-15 4-25 4-25	40 25 20 15	992 E	LIBEG, VERY BOULDERY LIBEG, BOULDERY NIEMAN, BOULDERY INCLUSIONS	15-45 15-45 15-45	40 30 25 5
742 E	SHAWMUT, STONY MARTINSDALE, VERY STONY INCLUSIONS	15-25 4-15	60 30 10	1103 D	ADEL LIBEG INCLUSIONS	4-15 4-15	50 30 20
744 E	SHAWMUT, BOULDERY SHAWMUT, STONY TOLBERT, BOULDERY INCLUSIONS	15-35 15-35 15-35	45 20 20 15	1222 C	MARTINSDALE MARTINSDALE, STONY SHAWMUT INCLUSIONS	2-8 2-8 2-8	40 20 20 20
745 E	SHAWMUT, BOULDERY SHAWMUT, VERY BOULDERY TOLBERT, BOULDERY INCLUSIONS	15-45	50 25 20 5	1222 E	MARTINSDALE MARTINSDALE, STONY SHAWMUT INCLUSIONS	15-35 15-35 15-35	40 30 20 10
746 E	SHAWMUT TOLBERT INCLUSIONS	15-35 8-35	60 25 15	1223 D	MARTINSDALE, STONY SHAWMUT INCLUSIONS	2-15 2-15	40 25 35

ANALYTICAL RESULTS FOR HILGER SERIES

DATE SAMPLED: 9/20/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A 0 - 5 SFS-9309-200	Bt1 5 - 9 SFS-9309-201	Bt2 9 - 15 SFS-9309-202	Bk1 15 - 19 SFS-9309-203	Bk2 19 - 24 SFS-9309-204	BC 24 - 60 SFS-9309-205
PARAMETER	UNITS					
pH	5.9	6.1	7.0	7.6	7.7	7.5
Saturation	42.1	38.9	45.9	41.4	34.2	41.4
Specific Conductivity	0.40	0.54	1.14	0.50	0.66	1.66
Calcium	2.08	3.01	6.57	2.54	2.54	2.53
Magnesium	0.79	1.14	2.41	1.39	1.96	3.15
Sodium	0.27	0.33	0.45	0.67	1.37	7.72
Sodium Adsorption Ratio	0.23	0.23	0.21	0.48	0.91	4.58
Cation Exchange Capacity	43.33	56.00	57.82	45.54	37.91	63.68
Sand	40	44	44	62	62	56
Silt	42	27	31	19	25	19
Clay	18	29	25	19	13	25
Texture	L	CL	L	SL	SL	SCL
Very Fine Sand	<1	<1	<1	<1	<1	3.92
Rock Fragments	35	<2	33	35	<2	35
Organic Matter	3.2	1.2	1.2	0.7	0.5	0.2
Nitrate	4.3	1.0	<1	<1	<1	<1
Ammonia	3.8	5.2	2.5	1.4	1.4	2.0
Calcium Carbonate Equivalent	0.6	0.1	2.4	6.9	5.6	3.3
Neutralization Potential	6	1	24	69	56	33
Acid Potential	<1	1	<1	<1	<1	<1
Acid-Base Potential	6	1	24	69	56	33

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

TABLE 3-2 SOIL MAPPING UNIT COMPOSITION
(Continued) SANTA FE PACIFIC GOLD CORPORATION, ELKHORN PROJECT, JEFFERSON COUNTY, MONTANA

SYMBOL	SERIES IN MAPPING UNIT	SLOPE (percent)	PERCENT OF MAPPING UNIT	SYMBOL	SERIES IN MAPPING UNIT	SLOPE (percent)	PERCENT OF MAPPING UNIT
1322 D	BEAVERELL, STONY	2-15	30	1851 D	SHOOK	0-8	40
	BEAVERELL, RUBBLY	2-15	30		SLOCUM	0-8	20
	SIEBERELL, STONY	2-15	20		SILAS	0-8	20
	INCLUSIONS		20		INCLUSIONS		20
1341 D	WINDHAM VERY GRAVELLY LOAM	2-15	85	1951 E	FRANCONI	35-60	45
	INCLUSIONS		15		CASEYPEAK, VERY BOULDERY	35-60	35
					INCLUSIONS		20
1342 E	WINDHAM VERY COBBLY LOAM	15-45	70	2090 F	CASEYPEAK, VERY BOULDERY	25-60	45
	WINDHAM VERY COBBLY LOAM	15-45	25		ROCK RUBBLELAND		20
	INCLUSIONS		5		FRANCONI, VERY BOULDERY	25-60	15
1343 D	WINDHAM VERY COBBLY LOAM	4-15	60		INCLUSIONS		20
	JUDELL VERY COBBLY LOAM	4-15	30	2091 E	CASEYPEAK	8-35	45
	INCLUSIONS		10		ROCK RUBBLELAND		20
1563 D	HILGER, RUBBLY	8-25	50		FRANCONI	8-35	20
	HILGER	8-25	35		INCLUSIONS		15
	INCLUSIONS		15	2484 F	ROCK RUBBLELAND		60
1640 D	NIEMAN	2-15	35		REDFERN, RUBBLY	35-70	20
	ROCK OUTCROP		30		HELMVILLE, RUBBLY	35-70	15
	LIBEG, STONY	2-15	15		INCLUSIONS		5
	INCLUSIONS		20	2485 F	ROCK RUBBLELAND		45
1641 E	NIEMAN	15-45	50		REDFERN, RUBBLY	25-70	25
	ROCK OUTCROP		25		TIGERON, VERY BOULDERY	25-50	20
	LIBEG	15-45	20		INCLUSIONS		10
	INCLUSIONS		5	8102 E	TEPECREEK, BOULDERY	8-35	40
1642 F	NIEMAN	25-60	50		CASEYPEAK, VERY BOULDERY	8-35	35
	ROCK OUTCROP		25		ROCK RUBBLELAND		15
	LIBEG, VERY BOULDERY	25-60	25		INCLUSIONS		10
1643 E	NIEMAN, STONY	15-35	40	8102 F	TEPECREEK, BOULDERY	35-60	40
	LIBEG	15-35	35		CASEYPEAK, VERY BOULDERY	35-60	35
	INCLUSIONS		25		ROCK RUBBLELAND		15
1652 E	SAWBUCK	8-35	50		INCLUSIONS		10
	CLASOIL	8-35	25	8106 E	TEPECREEK, VERY BOULDERY	15-35	45
	INCLUSIONS		25		CASEYPEAK, VERY BOULDERY	15-35	30
1740 E	TROPAL, BOULDERY	8-25	35		ROCK RUBBLELAND		20
	HANSON, STONY	8-15	20		INCLUSIONS		5
	ROCK OUTCROP		20	8106 F	TEPECREEK, VERY BOULDERY	35-60	35
	INCLUSIONS		25		CASEYPEAK, VERY BOULDERY	35-60	25
1742 F	TROPAL	25-60	60		ROCK RUBBLELAND		25
	ROCK OUTCROP		30		INCLUSIONS		15
	INCLUSIONS		10	8107 F	ROCK RUBBLELAND		50
1743 E	DRYADINE	8-25	35		CASEYPEAK, VERY BOULDERY	15-60	35
	TROPAL	8-25	25		INCLUSIONS		15
	ROCK OUTCROP		15	8124 E	BOBOWIC	15-25	40
	INCLUSIONS		25		CASEYPEAK, BOULDERY	15-25	30
1743 F	DRYADINE	25-60	35		ROCK RUBBLELAND		15
	TROPAL	25-60	25		INCLUSIONS		15
	ROCK OUTCROP		30				
	INCLUSIONS		10				

ANALYTICAL RESULTS FOR HELMVILLE SERIES
DATE SAMPLED: 10/07/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	E 0 - 10 SFS-9309-330	Bt1 10 - 18 SFS-9309-331	Bt2 18 - 38 SFS-9309-332	Bk 38 - 60 SFS-9309-333
PARAMETER	UNITS			
pH	6.5	6.4	6.7	7.5
Saturation	22.7	27.7	25.1	21.7
Specific Conductivity	0.86	0.59	0.56	1.50
Calcium	6.20	3.47	3.38	11.90
Magnesium	1.96	1.43	1.31	1.76
Sodium	0.44	0.30	0.33	0.50
Sodium Adsorption Ratio	0.22	0.19	0.22	0.19
Cation Exchange Capacity	20.0	31.0	25.6	16.7
Sand	58	56	62	64
Silt	35	29	27	29
Clay	7	15	11	7
Texture	SL	SL	SL	SL
Very Fine Sand	4	4	8	7
Rock Fragments	54	46	<2	51
Organic Matter	1.2	0.7	0.5	0.3
Calcium Carbonate Equivalent	0.7	0.7	0.8	0.3
Neutralization Potential	7	7	8	3
Acid Potential	<1	<1	<1	<1
Acid-Base Potential	7	7	8	3

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

annual soil temperature between 32 and 46 degrees Fahrenheit) and, with the exception of the soil association present in alluvial landscapes (Shook-Slocum-Silas), slopes are generally greater than 25 percent. The mountain soils are usually present with rock outcrop in both forested and open landscapes.

Caseypeak-Bobowic-Franconi association

This association consists of very steep to moderately sloping soils on mountain tops and slopes. These soils are formed in colluvium and residuum derived from diorite in the northern portion of the project area. Rock outcrop and rubble can be included in the association.

Caseypeak soil is shallow, well-drained and is present on 25 to 60 percent slopes. Below the surface organic (O) horizon is approximately 5 inches of light brownish-gray gravelly coarse sandy loam underlain by brown very gravelly coarse sandy loam. Bedrock is at approximately 19 inches. Caseypeak soil is also present in association with Tepecreek soil.

Bobowic soil is moderately deep, well-drained and is present on 25 to 60 percent slopes. The surface layer typically is grayish-brown very gravelly coarse sandy loam about 2 inches thick underlain by brown gravelly coarse sandy loam. Bedrock is at a depth of approximately 35 inches.

Franconi soil is moderately deep and well-drained and is also present on 25 to 60 percent slopes. The surface layer typically is a brown gravelly sandy clay loam approximately 4 inches thick. This is underlain by brown to yellowish brown gravelly sandy clay loam with bedrock at approximately 34 inches.

Tepecreek-Caseypeak-Rock Outcrop association

This association consists of very steep to moderately sloping soils on mountain tops and slopes. These soils are associated with colluvium or residuum derived from quartz monzonite of the Boulder Batholith and cover an extensive area in the northeast portion of the project area. A brief and general description of Caseypeak soil is in the previous section.

ANALYTICAL RESULTS FOR HANSON SERIES
DATE SAMPLED: 10/07/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A1 0 - 8 SFS-9309-326	A2 8 - 14 SFS-9309-327	Bk1 14 - 21 SFS-9309-328	Bk2 21 - 43 SFS-9309-329
PARAMETER	UNITS			
pH	6.5	7.0	7.5	7.8
Saturation	56.8	35.8	31.6	25.4
Specific Conductivity	1.10	0.81	0.57	0.53
Calcium	8.87	6.76	4.54	3.96
Magnesium	2.30	1.55	1.47	1.42
Sodium	0.47	0.13	0.16	0.29
Sodium Adsorption Ratio	0.20	0.06	0.09	0.18
Cation Exchange Capacity	65.7	55.2	21.5	12.8
Sand	32	36	58	66
Silt	51	49	33	26
Clay	17	15	9	8
Texture	SIL	L	SL	SL
Very Fine Sand	5	<1	1	5
Rock Fragments	<2	44	61	68
Organic Matter	7.1	3.8	1.6	<0.1
Nitrate	2.5	2.4	1.4	1.0
Ammonia	5.0	2.8	1.0	1.2
Calcium Carbonate Equivalent	7.5	24.9	52.9	53.3
Neutralization Potential	75	249	529	533
Acid Potential	<1	<1	<1	<1
Acid-Base Potential	75	249	529	533

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

Tepecreek soil is moderately deep, well-drained and occurs on 25-60 percent slopes. Below the O horizon, the surface layer typically is a grayish-brown gravelly sandy clay loam about 2 inches thick. This is underlain by brown to yellowish-brown gravelly sandy clay loam with bedrock at approximately 52 inches.

Shook-Slocum-Silas association

This association consists of mostly nearly level and gently sloping soils on low terraces of streams in mountain valley landscapes. This association is made up of 40 percent Shook soil, 20 percent Slocum soil, 20 percent Silas soil with up to 20 percent inclusions.

Shook soil is moderately deep, well-drained and is present on terrace edges and drainageways on granitic uplands and sideslopes. Slopes range from 8 to 25 percent and the surface horizon is a dark grayish brown loam about 7 inches thick. Subsurface soil is yellowish brown to dark grayish brown sandy loam with bedrock at approximately 26 inches.

Slocum soil is deep, somewhat poorly drained soil on terraces and floodplains with 0-4 percent slopes. The surface horizon typically is dark gray loam about 10 to 15 inches thick underlain by gray to brownish gray sandy to clay loam.

Silas soil is very deep, moderately well-drained soil also on terraces and floodplains. The surface horizon typically is a very dark grayish brown loam about 10 inches thick underlain by dark grayish brown to brown loam.

3.2.2 Cryic Soils Formed in Alluvium, Colluvium or Residuum from Volcanics, Shale, Argillite, Hornfels, Skarn, and Porphyry

These soils are cryic and are present on mountain sides, hilltops, footslopes, fans, and terraces from a variety of parent materials. These soils are shallow to very deep, well-drained and are present on 4-60 percent slopes.

ANALYTICAL RESULTS FOR FRANCONI(2) SERIES
DATE SAMPLED: 10/06/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	E 0 - 8 SFS-9309-320	E/Bt 8 - 14 SFS-9309-321	B/E 14 - 19 SFS-9309-322	Bt1 19 - 30 SFS-9309-323	Bt2 30 - 41 SFS-9309-324	Cr 41+ SFS-9309-325
PARAMETER	UNITS					
pH	6.1	6.4	6.6	6.7	6.6	6.9
Saturation	32.1	29.2	24.8	27.5	29.2	25.3
Specific Conductivity	0.29	0.22	0.23	0.18	0.18	0.12
Calcium	2.03	1.44	1.44	1.04	0.99	0.82
Magnesium	0.72	0.49	0.59	0.54	0.59	0.75
Sodium	0.14	0.18	0.20	0.13	0.19	0.22
Sodium Adsorption Ratio	0.12	0.18	0.20	0.15	0.21	0.25
Cation Exchange Capacity	18.3	25.6	25.4	28.5	30.4	24.1
Sand	58	60	64	55	57	74
Silt	40	35	36	43	40	26
Clay	2	5	0	2	3	0
Texture	SL	SL	SL	SL	SL	LS
Very Fine Sand	5	4	5	5	7	8
Rock Fragments	51	<2	<2	<2	48	<2
Organic Matter	2.2	1.0	0.7	0.5	0.5	<0.1
Calcium Carbonate Equivalent	0.5	0.6	0.7	0.8	1.0	1.5
Neutralization Potential	5	6	7	8	10	15
Acid Potential	<1	<1	<1	<1	<1	<1
Acid-Base Potential	5	6	7	8	10	15

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

Libeg-Nieman-Adel association

This association consists of gently sloping to moderately steep soils on alluvial fans, slopes and mountain tops and can contain up to 5 percent other soils. Soils in this association are formed in alluvium and volcanic colluvium and residuum. Rock outcrop can be included in this association.

Libeg soil is very deep, well-drained, and occurs on 15-45 percent slopes. The surface layer is a dark gray very gravelly loam about 10 inches thick underlain by brown to light yellowish brown gravelly, cobbly clay loam. The parent material is dominantly colluvium derived from igneous rocks. Libeg soil also occurs as an exclusive association on alluvial fans. In this setting, Libeg soil is a very gravelly loam on 15-35 percent slopes and can contain up to 15 percent inclusions.

Nieman soil is shallow, well-drained and is present on 15-60 percent slopes. The surface layer is 4-6 inches thick and consists of grayish brown very cobbly loam. The subsoil is brown extremely cobbly clay loam and volcanic bedrock is 15-16 inches below the surface.

Adel soil is formed in alluvium and is present on fans, terraces, slopes and upland swales. Adel soil is very deep, well-drained, and occurs on 4-15 percent slopes. The surface layer is 8-14 inches thick and consists of dark gray loam underlain by dark brown loam.

Tigeron - Redfern - Rock Outcrop association

This association consists of strongly sloping to very steep, well-drained soils on mountain sideslopes and can contain up to 10 percent other soils as inclusions. This association is formed in alluvium or colluvium from igneous or siliceous sedimentary parent material. Rock outcrop makes up 15 percent of this association.

Tigeron soil is very deep, well-drained and is present on 15-45 percent slopes. Below the surface organic (O) horizon, the surface layer is 2-3 inches thick and consists of grayish brown very cobbly loam. The subsoil is grayish brown to yellowish brown very cobbly sandy clay loam.

ANALYTICAL RESULTS FOR FRANCONI SERIES
DATE SAMPLED: 9/29/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	E 0 - 6 SFS-9309-289	E/Bt 6 - 11 SFS-9309-285	B/E 11 - 17 SFS-9309-290	Bt1 17 - 24 SFS-9309-291	Bt2 24 - 32 SFS-9309-292	Cr 32+ SFS-9309-293
PARAMETER	UNITS					
pH	6.3	6.7	6.9	6.7	6.7	7.2
Saturation	33.9	34.4	28.8	30.5	29.8	25.0
Specific Conductivity	0.24	0.31	0.24	0.22	0.28	0.11
Calcium	1.50	1.81	1.29	1.02	1.34	0.56
Magnesium	1.21	1.42	1.40	1.09	1.43	0.85
Sodium	0.17	0.21	0.22	0.23	0.23	0.16
Sodium Adsorption Ratio	0.15	0.17	0.19	0.22	0.20	0.19
Cation Exchange Capacity	35.58	34.14	30.69	30.98	33.42	25.09
Sand	71	74	73	74	75	88
Silt	20	19	20	21	18	11
Clay	9	7	7	5	7	1
Texture	SL	SL	SL	SL	SL	S
Very Fine Sand	4.08	9.22	11.30	4.04	5.90	6.96
Rock Fragments	<2	41	56	42	<2	<2
Organic Matter	3.0	1.2	1.0	0.7	0.5	<0.1
Nitrate	1.1	<1	<1	<1	<1	<1
Ammonia	1.4	1.2	<1	<1	<1	<1
Calcium Carbonate Equivalent	1.4	1.4	1.4	1.5	1.6	1.7
Neutralization Potential	14	14	14	15	16	17
Acid Potential	<1	<1	<1	<1	<1	<1
Acid-Base Potential	14	14	14	15	16	16

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

Redfern soil is shallow, well-drained and is present on 15-45 percent slopes. The surface layer is 3 inches thick below the O horizon and consists of light brownish gray very cobbly loam. The subsoil is light gray to yellowish brown gravelly loam to gravelly clay loam. Helmville soil is also associated with Redfern soil.

3.2.3 Cryic Soils Formed in Alluvium, Colluvium or Residuum from Carbonate Rocks

The following soils are cryic and are located mainly on mountains, hills and slopes in areas dominated by carbonate (limestone) rock types. These soils are shallow to very deep, well-drained, and occur on 2-60 percent slopes.

Dryadine-Tropal-Hanson association

This association consists of moderately sloping to very steep, well-drained soils on mountains and side slopes. These soils are formed in colluvium and residuum from carbonate (limestone) rock types. Rock outcrop can be included and all three soils need not be represented in the association.

Dryadine soil is effervescent, moderately deep, well-drained and is present on 2-45 percent slopes. The surface soil is dark grayish brown gravelly loam about 4 inches thick and is underlain by yellow to brown, violently effervescent cobbly loam. Limestone bedrock is at 36 inches. Dryadine soil can be present in association with Whitore soil.

Tropal soil is violently effervescent, shallow, well-drained and is present on 25-60 percent slopes. The soil is brown to light gray very gravelly loam with limestone bedrock at approximately 16 inches. Tropal soil can be present in association with Whitore soil.

Hanson soil is strongly effervescent, very deep and well-drained. This soil is formed in till in mountain valley landscapes and is present on 8-15 percent slopes. The surface soil is very dark grayish brown loam approximately 6 inches thick and is underlain by violently effervescent, grayish brown loam to cobbly loam.

ANALYTICAL RESULTS FOR DRYADINE(2) SERIES
DATE SAMPLED: 9/28/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	E 0 - 4 SFS-9309-266	E/Bk 4 - 7 SFS-9309-267	Bk/E 7 - 11 SFS-9309-268	Bk 11 - 16 SFS-9309-269	Ck 16 - 24 SFS-9309-270	Cr 24 - 60 SFS-9309-271
PARAMETER	UNITS					
pH	7.3	7.6	7.5	7.7	8.0	8.7
Saturation	56.4	42.8	40.5	35.1	30.8	29.8
Specific Conductivity	1.14	0.78	0.73	0.53	0.39	0.51
Calcium	7.56	4.28	3.87	3.30	2.41	1.40
Magnesium	6.34	6.20	5.37	3.80	2.49	5.35
Sodium	0.13	0.18	0.15	0.12	0.13	0.35
Sodium Adsorption Ratio	0.05	0.08	0.07	0.06	0.08	0.19
Cation Exchange Capacity	66.09	40.12	34.35	24.22	16.70	10.34
Sand	55	68	72	72	69	70
Silt	39	29	23	25	22	30
Clay	6	3	5	3	9	N/A
Texture	SL	SL	SL	SL	SL	SL
Very Fine Sand	6.64	4.32	6.80	6.24	4.16	9.50
Rock Fragments	47	N/A	55	61	51	71
Organic Matter	7.7	4.2	3.7	2.1	0.5	0.3
Calcium Carbonate Equivalent	14.8	33.0	35.6	40.3	45.8	68.7
Neutralization Potential	148	330	356	403	458	687
Acid Potential	<1	<1	<1	<1	<1	<1
Acid-Base Potential	148	330	356	403	458	687

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

Helmville soil

This soil occurs on moderately sloping to very steep mountain sideslopes and is formed in alluvium and colluvium derived from limestone, argillite, and igneous rocks. Helmville soil is effervescent, very deep, well-drained and is present on 15-45 percent slopes. The surface layer is light brownish gray cobbly loam approximately 10 inches thick underlain by yellowish brown very cobbly clay loam which is violently effervescent in its deeper horizons.

3.2.4 Frigid Soils Formed in Alluvium or Colluvium from Igneous and Sedimentary Rocks

The following soils are mainly on raised benches, alluvial fans, foothills, ridges, and drainageways and are formed in alluvium or colluvium from a variety of source rocks. These soils are shallow to very deep, well-drained and are present in the frigid temperature regime (mean annual temperature is less than 46 degrees Fahrenheit and summer temperature is higher than summer temperature for cryic regime).

Brownshtut association

This association is on gently sloping alluvial fans and raised benches and can contain up to 10 percent other soils. Brownshtut soil is deep, well-drained and occurs on 1-4 percent slopes. The surface layer is 2 inches thick and consists of dark grayish brown gravelly loam which is underlain by effervescent gravelly to cobbly loam.

Crago-Rock Outcrop-Pensore association

This association consists of gently sloping, well-drained soils on foothills and dissected uplands and can contain up to 10 percent other soils as inclusions. This association is formed in alluvium and colluvium from carbonate (limestone) rock types. Rock outcrop can make up 25 percent of the association and not all components need be represented for the association to be complete.

Crago soil is violently effervescent, very deep, well-drained and is present on 2-15 percent slopes. The surface layer is 4 inches thick and is composed of brown gravelly loam. The subsoil is yellowish to pale brown gravelly loam.

ANALYTICAL RESULTS FOR DRYADINE SERIES
DATE SAMPLED: 10/05/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A 0 - 6 SFS-9309-307	Bw 6 - 16 SFS-9309-308	Bk 16 - 29 SFS-9309-309	C 29 - 40 SFS-9309-310
PARAMETER	UNITS			
pH	7.5	7.6	7.8	7.8
Saturation	14.2	19.3	33.6	28.5
Specific Conductivity	0.72	0.49	0.38	0.35
Calcium	7.04	4.64	3.63	3.38
Magnesium	1.53	0.87	0.63	0.51
Sodium	0.12	0.11	0.19	0.16
Sodium Adsorption Ratio	0.06	0.07	0.13	0.11
Cation Exchange Capacity	54.4	42.3	26.3	13.4
Sand	39	44	57	72
Silt	47	45	38	25
Clay	14	11	5	3
Texture	L	L	SL	SL
Very Fine Sand	4	<1	2	7
Rock Fragments	53	69	66	16
Organic Matter	6.7	2.9	2.1	1.4
Calcium Carbonate Equivalent	35.9	34.9	52.8	59.1
Neutralization Potential	359	349	528	591
Acid Potential	<1	<1	<1	<1
Acid-Base Potential	359	349	528	591

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

Pensore soil is shallow, well-drained, violently effervescent and is present on 2-15 percent slopes. The surface layer is 4 inches thick and is composed of a grayish brown gravelly loam. The subsoil is light gray very gravelly loam and hard limestone bedrock is within 16 inches of the surface.

Maiden - Lap - Windham association

This association consists of gently sloping to very steep, well-drained soils on hilltops, slopes, uplands and lowlands and can contain up to 15 percent other soils as inclusions. This association is formed in colluvium and residuum from carbonate (limestone) rock types. This association is variable in that rock outcrop can be included and all three soil types need not be represented.

Maiden soil is effervescent, moderately deep, well-drained and is present on 4-60 percent slopes. The surface layer is 3-6 inches thick and consists of dark grayish brown gravelly loam underlain by light gray to light brown gravelly to cobbly loam.

Lap soil is effervescent, shallow, well-drained and is present on 4-60 percent slopes. The surface layer is 4-7 inches thick and is typically a dark grayish brown very gravelly loam. The subsurface soil is light brownish gray to brown extremely gravelly loam. Limestone bedrock is at a depth of about 18 inches.

Windham soil is very deep, effervescent, well-drained and is present on 4-60 percent slopes. The surface layer is 2-8 inches thick and consists of dark grayish brown gravelly loam which is typically underlain by pale brown, violently effervescent very gravelly loam. It should be noted that Windham soil can form an exclusive association.

Judell soil

This soil is formed in calcareous alluvium and is present on terraces and fans. Judell soil is very deep, well-drained, and occurs on 2-15 percent slopes. The surface layer is 5 inches thick and consists of grayish brown very cobbly loam. The subsoil is white to brown,

ANALYTICAL RESULTS FOR CASEY PEAK(2) SERIES
DATE SAMPLED: 9/29/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	E 0 - 5 SFS-9309-286	Bw 5 - 14 SFS-9309-287	Cr 14 - 18 SFS-9309-288
PARAMETER	UNITS		
pH	(s.u.)	7.0	7.7
Saturation	(%)	59.2	36.8
Specific Conductivity	(mmhos/cm)	0.36	0.42
Calcium	(meq/l)	1.04	1.01
Magnesium	(meq/l)	3.89	3.34
Sodium	(meq/l)	0.06	0.14
Sodium Adsorption Ratio		0.04	0.09
Cation Exchange Capacity	(meq/100g)	51.90	31.84
Sand	(%)	64	74
Silt	(%)	33	26
Clay	(%)	3	N/A
Texture		SL	LS
Very Fine Sand	(%)	10.26	11.30
Rock Fragments	(%)	32	60
Organic Matter	(%)	4.4	1.0
Calcium Carbonate Equivalent	(%)	2.5	4.1
Neutralization Potential	(V/1000t)	25	41
Acid Potential	(V/1000t)	1	1
Acid-Base Potential	(V/1000t)	24	41

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

violently effervescent very cobbly to very gravelly clay loam. Judell soil is present in association with Windham soil.

Martinsdale soil

This soil is formed in alluvium and is present on foothill slopes and drainageways, alluvial fans, and stream terraces. Martinsdale soil is very deep, well-drained, and occurs on 2-35 percent slopes. The surface layer is 5-8 inches thick and consists of dark grayish brown loam to cobbly sandy clay loam. The underlying material has a variable color (white, yellowish brown, light gray, or brown) and texture (gravelly, gravelly clay, clay loam, loam, or gravelly sandy clay loam). Martinsdale soil is present in association with Hilger soil and with Shawmut soil.

Hilger soil

This soil is present on low foothills and is formed in alluvium or colluvium from an igneous source. Hilger soil is deep, well-drained and occurs on 2-25 percent slopes. The surface layer is 5-8 inches thick and consists of dark grayish brown very cobbly loam. The subsoil is a brown to yellowish brown cobbly to cobbly clay loam which effervesces. Hilger soil is present as an exclusive association and in association with Martinsdale soil.

Shawmut soil

This soil is formed in alluvium or colluvium from igneous parent material and is present on low hills and slopes. Shawmut soil is very deep, well-drained, and occurs on 4- 45 percent slopes. The surface layer is 5-7 inches thick and consists of grayish brown gravelly loam to gravelly sandy clay loam which is underlain by gray to yellowish brown gravelly sandy clay loam which effervesces. Shawmut soil is present as an exclusive association and in association with both Martinsdale soil and Tolbert soil.

Tolbert soil

This soil is formed in colluvium from igneous parent material and is present on hills and slopes. Tolbert soil is shallow, well-drained and is present on 8-45 percent slopes. The surface layer is 4-7 inches thick and consists of grayish brown cobbly loam underlain by

ANALYTICAL RESULTS FOR CASEY PEAK SERIES
DATE SAMPLED: 9/23/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	E 0 - 4 SFS-9309-262	BW 4 - 9 SFS-9309-263	BC 9 - 12 SFS-9309-264	Cr 12 - 17 SFS-9309-265
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PARAMETER	UNITS	5.2	5.0	5.9	6.5
pH	(s.u.)	39.2	27.7	31.9	29.6
Saturation	(%)	0.32	0.26	0.20	0.23
Specific Conductivity	(mmhos/cm)	1.84	1.49	1.07	1.09
Calcium	(meq/l)	0.75	0.51	0.36	0.52
Magnesium	(meq/l)	0.12	0.24	0.22	0.35
Sodium	(meq/l)	0.11	0.24	0.26	0.39
Sodium Adsorption Ratio	(meq/100g)	33.92	24.07	22.90	10.70
Cation Exchange Capacity	(%)	63	70	80	88
Sand	(%)	31	27	17	12
Silt	(%)	6	3	3	N/A
Clay	(%)	SL	SL	LS	S
Texture	(%)	1.58	2.54	6.30	11.56
Very Fine Sand	(%)	<2	<2	<2	42
Rock Fragments	(%)	4.3	1.0	3.4	<0.1
Organic Matter	(%)	0.6	0.7	1.3	0.8
Calcium Carbonate Equivalent	(l/1000t)	6	7	13	8
Neutralization Potential	(l/1000t)	<1	<1	<1	<1
Acid Potential	(l/1000t)	6	7	13	8
Acid-Base Potential	(l/1000t)				

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

brown cobbly clay loam. Bedrock is 11-12 inches below the surface. Tolbert soil is found associated with Shawmut soil.

Whitecow-Warneke-Rock Outcrop association

This association consists of strongly sloping to very steep, well-drained soils on mountain sideslopes and can contain up to 20 percent other soils. This association is formed in colluvium and residuum from carbonate (limestone) rock types. Rock outcrop can be included in this association.

Whitecow soil is very deep, well-drained and is present on 8-60 percent slopes. Below the O horizon, the surface layer is about 5 inches thick and consists of dark grayish brown gravelly loam. The subsoil is strongly effervescent light gray to brown very gravelly loam. Whitecow soil can also be associated with Shawmut soil.

Warneke soil is shallow, well-drained and is present on 8-60 percent slopes. This soil also has an O horizon and the surface soil underneath is about 4 inches thick and consists of violently effervescent very stony loam. Limestone bedrock is about 11-12 inches from the surface.

Sieben-Varney-Sieberell association

This association consists of gently sloping, well-drained soils on alluvial fans and stream terraces. These soils, the deeper horizons of which are effervescent, are formed in alluvium from a variety of rock sources. All soil types need not be represented for the association to be complete.

Sieben soil is very deep, well-drained and is present on foothills and alluvial fans with 2-15 percent slopes. The surface layer typically is dark grayish brown, cobbly loam about 3 inches thick. The underlying soil is grayish brown to brown cobbly clay loam to very gravelly clay loam.

Varney soil is very deep, well-drained, and occurs on alluvial fans, terraces, and hills with 15-25 percent slopes. The surface layer is typically a dark grayish brown loam about

ANALYTICAL RESULTS FOR BROWNSHUT SERIES
DATE SAMPLED: 9/21/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A 0 - 2 SFS-9309-233	Bk1 2 - 8 SFS-9309-234	Bk2 8 - 15 SFS-9309-235	Bk3 15 - 26 SFS-9309-236	Bk4 26 - 35 SFS-9309-237	BC 35 - 60 SFS-9309-238
PARAMETER	UNITS					
pH	7.2	7.5	7.9	8.1	8.5	8.4
Saturation	45.1	44.6	32.6	26.8	20.2	25.4
Specific Conductivity	1.15	0.55	0.32	0.50	0.63	0.85
Calcium	8.98	3.83	1.88	1.06	0.64	0.66
Magnesium	2.12	1.19	1.36	2.86	3.61	4.26
Sodium	0.10	0.10	0.21	0.66	1.78	3.29
Sodium Adsorption Ratio	0.04	0.06	0.16	0.47	1.22	2.10
Cation Exchange Capacity	40.66	39.46	28.76	29.29	14.31	20.20
Sand	58	40	53	66	72	58
Silt	34	41	34	26	24	32
Clay	8	19	13	8	4	10
Texture	SL	L	SL	SL	SL	SL
Very Fine Sand	10.96	<1	<1	23.10	3.58	6.88
Rock Fragments	<2	<2	60	61	79	39
Organic Matter	6.8	3.1	1.2	1.4	0.3	0.7
Nitrate	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Ammonia	5.8	1.4	1.2	<1	<1	<1
Calcium Carbonate Equivalent	3.4	1.3	<1	<1	<1	<1
Neutralization Potential	41.7	57.3	70.8	72.7	73.6	47.7
Acid Potential	417	573	708	727	736	477
Acid-Base Potential	<1	1	1	<1	<1	<1
	417	572	707	727	736	477

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

7 inches thick and is underlain by yellowish brown to light gray, strongly effervescent clay loam.

Sieberell soil is very deep, well-drained and is present on stream terraces and alluvial fans. The surface layer is typically a grayish brown extremely gravelly loam about 6 inches thick. The subsoil is a yellowish brown to olive brown gravelly clay loam to cobbly loamy sand.

Beaverell soil

This soil is very deep, well-drained and is formed in alluvium on stream terraces and alluvial fans with 2-15 percent slopes. The surface layer is typically a dark grayish brown stony to cobbly sandy clay loam from 5-7 inches thick. The subsoil is brown cobbly sandy loam.

3.2.5 Poorly Drained Soils Formed in Alluvium

The following soils occur mainly on stream terraces, flood plains, alluvial fans, and are formed in alluvium. These soils are very deep, somewhat poorly to well-drained, gravelly loams, fine sandy loams, silt loams, and silty clay loams. It should be noted that some mapping units in this category are not described as associated series but rather soil subgroups (i.e. Typic Haploborolls, Fluvaquentic Haplaquolls, Cumullic Haplaquolls, Ustic Torriorthents and Typic Fluvaquents). These soil subgroups occur on narrow, nearly level, undulating or gently sloping low terraces and flood plains of Elkhorn Creek and Turnley Creek. These soils typically have a black, organic rich surface layer underlain by black to gray (gleyed), mottled, subsurface horizons of organic rich, very fine loamy sand or finer material. The water table is generally very near the surface as soils in these subgroups are mainly near streams on floodplains or wet areas.

Fairway-Nestley association

This association consists of mostly nearly level and gently sloping soils on floodplains and low terraces. This association is made up of 60 percent Fairway soils, 30 percent Nestley soils, and 10 percent other soils.

ANALYTICAL RESULTS FOR BOBOWIC(2) SERIES
DATE SAMPLED: 9/30/93

HORIZON	E	Bw	Cr
INTERVAL (inches)	0 - 5	5 - 28	28 - 53
SAMPLE NUMBER	SFS-9309-299	SFS-9309-300	SFS-9309-301
PARAMETER	UNITS		
pH	(s.u.)	5.9	6.3
Saturation	(%)	42.9	26.1
Specific Conductivity	(mmhos/cm)	0.30	0.30
Calcium	(meq/l)	2.38	2.01
Magnesium	(meq/l)	0.81	0.64
Sodium	(meq/l)	0.16	0.23
Sodium Adsorption Ratio		0.13	0.20
Cation Exchange Capacity	(meq/100g)	41.76	30.55
Sand	(%)	58	73
Silt	(%)	33	24
Clay	(%)	9	3
Texture		SL	SL
Very Fine Sand	(%)	3.30	5.78
Rock Fragments	(%)	<2	45
Organic Matter	(%)	5.0	0.7
Calcium Carbonate Equivalent	(%)	1.4	3.0
Neutralization Potential	(t/1000t)	14	30
Acid Potential	(t/1000t)	<1	2
Acid-Base Potential	(t/1000t)	14	28

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

Fairway soils are very deep, somewhat poorly drained soils on floodplains with 0-2 percent slopes. The surface layer typically is dark grayish brown, slightly effervescent clay loam about 7 inches thick. It is underlain by dark grayish brown silty clay loam to silt loam.

Nestley soils are very deep, somewhat poorly drained soils on floodplains and low terraces with 0-2 percent slopes. The surface layer typically is dark grayish brown clay loam about 6 inches thick and is underlain by dark grayish brown coarse sand and clay loam.

3.3 SOIL PROFILE DESCRIPTIONS

This section describes each soil series in detail. Each layer or genetic horizon in the profile is described from the surface down to bedrock or other underlying layers to a depth of 60 inches. The profile descriptions provide information on the morphology of each series and is used to evaluate the suitability of project area soils for salvage and reclamation purposes.

The soil profile descriptions are organized in alphabetical order. Series which have a "description location" were described and sampled within the Elkhorn Project area.

Series with a "type location" were described by the SCS and are included in project area mapping units but were not sampled (Figure 2).

ANALYTICAL RESULTS FOR BOBOWIC SERIES
DATE SAMPLED: 9/28/93

HORIZON INTERVAL (inches) SAMPLE NUMBER	A 0 - 4 SFS-9309-272	E 4 - 11 SFS-9309-273	Bw 11 - 21 SFS-9309-274	Cr 21 - 53 SFS-9309-275
PARAMETER	UNITS			
pH	6.4	5.9	6.4	6.3
Saturation	37.3	31.9	26.7	27.7
Specific Conductivity	0.61	0.29	0.33	0.21
Calcium	4.60	1.92	2.41	1.56
Magnesium	1.55	0.68	0.72	0.61
Sodium	0.13	0.15	0.46	0.26
Sodium Adsorption Ratio	0.07	0.13	0.37	0.25
Cation Exchange Capacity	30.56	29.98	15.83	18.89
Sand	69	68	72	70
Silt	28	32	25	30
Clay	3	N/A	3	N/A
Texture	SL	SL	SL	SL
Very Fine Sand	4.96	4.06	3.88	2.88
Rock Fragments	<2	<2	49	25
Organic Matter	2.9	2.2	0.9	0.5
Calcium Carbonate Equivalent	0.7	0.5	0.7	0.8
Neutralization Potential	7	5	7	8
Acid Potential	<1	<1	<1	<1
Acid-Base Potential	7	5	7	8

TEXTURE: S = Sand; Si = Silt; L = Loam; C = Clay

ADEL SERIES

The Adel series consists of deep, well-drained soils that formed in alluvium or colluvium from a variety of rock sources. These soils are on fans, terraces, smooth to concave foot slopes and side slopes, and in upland swales. Slopes are 0 to 65 percent. Mean annual precipitation is about 25 inches. Mean annual temperature is about 40° F.

TAXONOMIC CLASS: Fine-loamy, mixed Pachic Cryoborolls

TYPICAL PEDON: Adel silt loam, grassland (colors are for dry soil unless otherwise noted).

A1 -- 0 to 13 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate medium and fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots; many very interstitial pores; many worm casts; slightly acid (pH 6.1); gradual wavy boundary. (8 to 14 inches thick)

A2 -- 13 to 31 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots; many very fine and fine pores; many worm casts; slightly acid (pH 6.1); diffuse wavy boundary. (8 to 20 inches thick)

A3 -- 31 to 38 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure parting to moderate fine and very fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; many fine and very fine pores; neutral (pH 7.0); gradual wavy boundary. (4 to 16 inches thick)

Bw -- 38 to 60 inches; brown (10YR 5/3) channery loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure parting to moderate very fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine pores; 20 percent angular pebbles and 5 percent angular cobbles; neutral (pH 7.0);

TYPE LOCATION: Lake County, Montana; 1,050 feet west and 450 feet south of the NE corner of Section 9, T. 13N, R. 18E.

APPENDIX A.
LABORATORY ANALYTICAL RESULTS

BEAVERELL SERIES

The Beaverell series consists of very deep, well-drained soils that formed in alluvium that is 10 to 20 inches deep over very gravelly loamy sand or very gravelly sand. These soils are on stream terraces, outwash terraces, and alluvial fans. Slopes are 0 to 25 percent. Mean annual precipitation is about 12 inches. Mean annual air temperature is about 41° F.

TAXONOMIC CLASS: Loamy-skeletal over sandy or sandy-skeletal, mixed Aridic Argiborolls.

TYPICAL PEDON: Beaverell gravelly loam, grassland (colors are for dry soil unless otherwise noted).

A -- 0 to 3 inches; brown (10YR 5/3) gravelly loam, dark brown (10YR 3/3) moist; weak very fine granular structure; slightly hard, very friable, slightly sticky and nonplastic; many fine and very fine roots; many fine and medium pores; 15 percent pebbles; neutral (pH 6.6); clear smooth boundary. (2 to 6 inches thick)

Bt1 -- 3 to 9 inches; brown (10YR 5/3) very gravelly clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate medium and fine blocky; hard, friable, sticky and slightly plastic; many fine and very fine roots; many fine and very fine pores; many faint clay films on faces of peds; 35 percent pebbles; neutral (pH 6.6); clear smooth boundary. (5 to 7 inches thick)

Bt2 -- 9 to 11 inches; brown (10YR 5/3) very gravelly sandy clay loam, dark brown (10YR 3/3) moist; moderate fine blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; many medium and fine pores; many faint clay films on faces of peds; 50 percent pebbles; lime coatings on underside of larger pebbles; neutral (pH 6.8); clear wavy boundary. (3 to 12 inches thick)

2Bk1 -- 11 to 17 inches; brown (10YR 5/3) very gravelly loamy sand, dark brown (10YR 4/3) moist; single grain; loose, very friable, nonsticky and nonplastic; common very fine roots; 60 percent pebbles; continuous distinct lime coatings on underside of smaller pebbles and lime casts on underside of larger pebbles; disseminated lime; strongly effervescent; mildly alkaline (pH 7.8); gradual wavy boundary. (4 to 25 inches thick)

2Bk2 -- 17 to 60 inches; brown (10YR 5/3) very gravelly sand, dark brown (10YR 4/3) moist; single grain; loose, soft and very friable; 60 percent pebbles; common faint lime coating on underside of pebbles; disseminated lime; strongly effervescent; mildly alkaline (pH 7.8).

TYPE LOCATION: Blaine County, Montana; 30 feet north and 1,000 feet west of the SE corner of Sec. 15, T. 33N., R. 23 E.

BOBOWIC SERIES

The Bobowic series consists of moderately deep, well-drained soils that formed in colluvium or residuum derived from granite bedrock. These soils are on dissected bedrock floored plains, hills, and mountains. Slopes are 15 to 70 percent. Mean annual precipitation is about 18 inches, and mean annual air temperature is about 38°F.

TAXONOMIC CLASS: Coarse-loamy, mixed Typic Cryochrepts

TYPICAL PEDON: Bobowic gravelly loam, very bouldery, forested, colors are for dry soil unless otherwise noted.

Oi -- 1 to 0 inches; partially decomposed needles, twigs and leaves. Can range from 1/2 to 3 inches thick.

A -- 0 to 4 inches; very dark gray (10YR 3/1) gravelly loam, (10YR 2/1) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine and fine and few medium pores; 20 percent pebbles; slightly acid (pH 6.4); clear smooth boundary. Can range from 0 to 5 inches thick.

E -- 4 to 11 inches; very dark gray (10YR 3/1) gravelly coarse sandy loam, (10YR 2/1) moist; moderate coarse platy structure parting to weak fine angular blocky; soft, very friable, slightly sticky and nonplastic; many very fine and few fine and medium roots; many very fine and few fine interstitial and tubular pores; 25 percent pebbles; moderately acid (pH 5.9); clear wavy boundary. Can range from 2 to 8 inches thick.

Bw -- 11 to 21 inches; dark grayish brown (10YR 4/2) gravelly coarse sandy loam, very dark brown (10YR 2/2) moist; fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; many very fine and few fine and medium roots; many very fine and few fine interstitial and tubular pores; 15 percent pebbles; 10 percent cobbles; slightly acid (pH 6.4); clear wavy boundary. Can range from 9 to 25 inches thick.

Cr -- 21 to 53 inches; grayish brown (10YR 5/2) decomposed granite bedrock (grus) that crushes to gravelly loamy coarse sand; very dark grayish brown (10YR 3/2) moist massive; 5 percent cobbles; slightly acid (pH 6.4); gradual wavy boundary.

R -- 53 inches; hard granite bedrock.

DESCRIPTION LOCATION: Jefferson County, Montana; 2,500 feet south and 1,700 feet west of the NE corner of Section 14, T. 6N, R. 3W.

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BOBOWIC (2) SERIES

The Bobowic (2) series consists of moderately deep, well-drained soils that formed in colluvium or residuum derived from granite bedrock. These soils are on dissected bedrock floored plains, hills, and mountains. Slopes are 15 to 70 percent. Mean annual precipitation is about 18 inches, and mean annual air temperature is about 38°F.

TAXONOMIC CLASS: Coarse-loamy, mixed Typic Cryochrepts

TYPICAL PEDON: Bobowic (2) gravelly loam, very bouldery, forested, colors are for dry soil unless otherwise noted.

Oi -- 1/2 to 0 inches; partially decomposed needles, twigs and leaves. Can range from 1/2 to 3 inches thick.

E -- 0 to 5 inches; very dark grayish brown (10YR 3/2) gravelly coarse sandy loam, (10YR 2/1) moist; moderate coarse platy structure parting to weak fine angular blocky; soft, very friable, slightly sticky and nonplastic; many very fine and few fine and medium roots; many very fine and few fine interstitial and tubular pores; 25 percent pebbles; moderately acid (pH 5.9); clear wavy boundary. Can range from 2 to 8 inches thick.

Bw -- 5 to 28 inches; dark grayish brown (10YR 4/2) gravelly coarse sandy loam, very dark brown (10YR 2/2) moist; fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; many very fine and few fine and medium roots; many very fine and few fine interstitial and tubular pores; 15 percent pebbles; 10 percent cobbles; moderately acid (pH 6.0); clear wavy boundary. Can range from 9 to 25 inches thick.

Cr -- 21 to 34 inches; dark grayish brown (10YR 4/2) decomposed granite bedrock (grus) that crushes to gravelly loamy coarse sand; very dark brown (10YR 2/2) moist; slightly acid (pH 6.3); gradual wavy boundary.

R -- 34+ inches; hard granite bedrock.

DESCRIPTION LOCATION: Jefferson County, Montana; 1,900 feet north and 700 feet east of the SW corner of Section 11, T. 6N, R. 3W.

21-Sep-94

TABLE 4-3 **CHEMICAL, PHYSICAL AND HYDROLOGIC CHARACTERISTICS OF POTENTIAL LAD SOILS**
SANTA FE PACIFIC GOLD CORPORATION, ELKHORN MINE PROJECT, JEFFERSON COUNTY, MONTANA

SERIES NAME	SLOPE RANGE (%)	Ave. CEC (meq/100g)	Ave. Clay (%)	Ave. OM (%)	Ave. CaCO ₃ Equiv. (%)	Ave. NO ₃ (ppm)	Ave. NH ₄ (ppm)	Est. Porosity (% by vol.)	Est. Field Capacity (% by vol.)	Est. Wilting Point (% by vol.)	Est. Saturated K (cm/s)
BROWNSHUT	0 - 60	25.41	10.3	2.3	60.6	1.7	1.1	45.5	16.5	9.0	0.00066
HANSON	0 - 35	38.80	12.3	3.2	34.7	1.8	2.5	46.8	22.4	10.5	0.00050
HILGER	8 - 25	50.71	21.5	1.2	3.2	1.2	2.7	44.9	23.3	12.1	0.00039
LIBEG	2 - 45	29.88	9.6	1.0	1.1	0.6	1.7	46.3	23.2	11.6	0.00037
MARTINSDALE	0 - 35	36.86	16.1	2.0	10.3	0.8	1.8	46.0	23.1	11.7	0.00043
SILAS	0 - 8	25.93	10.0	1.7	0.3	0.7	1.5	45.3	19.0	8.5	0.00072
WINDHAM	0 - 85	35.05	20.0	1.6	25.0	0.7	1.3	44.2	21.4	10.6	0.00048

BROWNSHUT SERIES

The Brownshtut series consists of very deep, well-drained soils that formed in alluvium and Tertiary fill material. These soils are on terraces, alluvial fans and hills. Slopes are 0 to 60 percent. Mean annual precipitation is about 12 inches. Mean annual air temperature is about 42° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed frigid Calciorthidic Ustochrepts

TYPICAL PEDON: Brownshtut gravelly loam, in rangeland (colors are for dry soil unless otherwise noted).

A -- 0 to 2 inches; grayish brown (10YR 5/2) gravelly loam, dark brown (10YR 3/3) moist; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; many fine and very fine pores; 15 percent pebbles; slightly effervescent; neutral (pH 7.2); clear wavy boundary. Can range from 2 to 6 inches thick.

Bk1 -- 2 to 8 inches; pale brown (10YR 6/3) gravelly loam, brown (10YR 5/3) moist; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; many fine and very fine pores; 25 percent pebbles; disseminated lime with few fine soft masses and threads of lime, common faint lime coatings on undersides of pebbles; strongly effervescent; mildly alkaline (pH 7.5); clear wavy boundary. Can range from 5 to 13 inches thick.

Bk2 -- 8 to 15 inches; very pale brown (10YR 7/3) gravelly loam, pale brown (10YR 6/3) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and slightly plastic; few fine and very fine roots; common fine and very fine pores; 30 percent pebbles; disseminated lime with common fine soft masses and threads of lime, common distinct lime coatings on pebbles; violently effervescent; mildly alkaline (pH 7.9); clear wavy boundary. Can range from 7 to 22 inches thick.

Bk3 -- 15 to 26 inches; pale brown (10YR 6/3) very gravelly sandy loam, brown (10YR 5/3) moist; weak coarse prismatic structure; slightly hard, very friable, slightly sticky and nonplastic; few very fine roots; common very fine pores; 45 percent pebbles; disseminated lime with common fine masses and threads of lime, common distinct lime coatings on underside of pebbles; violently effervescent; moderately alkaline (pH 8.1); clear wavy boundary. Can range from 10 to 15 inches thick.

Bk4 -- 26 to 35 inches; pale brown (10YR 6/3) very gravelly sandy loam, yellowish brown (10YR 5/4) moist; weak coarse prismatic structure; slightly hard, very friable, nonsticky and nonplastic; 45 percent pebbles; disseminated lime with few faint lime coatings on undersides of pebbles; violently effervescent; strongly alkaline (pH 8.5); gradual wavy boundary. Can range from 10 to 15 inches thick.

Hydrologic parameters considered for LAD soils include porosity, field capacity, wilting point and saturated hydraulic conductivity. These parameters were estimated for each potential LAD soils using Hydrologic Evaluation of Landfill Performance (HELP) model documentation (Schroeder 1988). Estimates of these properties are based on soil texture relationships. They are used to assess the water holding capacity, permeability and hydrologic conductivity characteristics of potential LAD soils and to evaluate application rates and surface area requirements for LAD systems.

The chemical, physical and hydrologic characteristics of LAD soils, averaged over genetic horizons for 5-foot deep profiles, are summarized in Table 4-3.

BROWNSHUT SERIES (Continued)

BC -- 35 to 60 inches; brown (10YR 5/3) very gravelly loamy sand, dark brown (10YR 3/3) moist; single grain; loose, nonsticky and nonplastic; 40 percent pebbles; few faint lime coatings on undersides of pebbles; strongly effervescent; moderately alkaline (pH 8.4).

DESCRIPTION LOCATION: Jefferson County, Montana; 1,200 feet west and 1,800 feet south of the NE corner of Section 10, T. 5N, R. 3W.

inches to optimize soil quality. The minimum depth of salvage was six inches which is the minimum amount of soil that equipment can remove with any degree of accuracy and the depth at which first lift quality was optimal for certain soils. From soil mapping unit composition information in Table 3-3, the area and extent of each series was calculated. The area and extent of each series is also included in Table 4-2. Rock outcrop and rock rubbleland, which account for approximately 1,110 acres or 12 percent of the total project area (8,957 acres) were not considered for salvage.

4.3 SUITABILITY OF SOILS FOR LAND APPLICATION DISPOSAL OF EXCESS PROJECT WATER

One of the objectives of the Elkhorn Mine Project soil inventory is to screen potential soils and sites suitable for land application disposal (LAD) of pit waters or process waters. Criteria used to identify potential LAD soils during field investigations included extent (surface area), soil depth, slope, texture, proximity to surface water and depth to groundwater. Soil series names identified include Brownshut, Hanson, Hilger, Libeg, Martinsdale, Silas and Windham. In the Elkhorn Project area, these soils are generally present on terraces, alluvial fans, mountain valleys, terraces and glacial till. They are suitable for LAD because they are deep, well-drained and usually occur on relatively level slopes.

Samples collected from soils identified in the field as having LAD potential were analyzed for nitrate and ammonium in addition to the other parameters specified in Table 2-1. These parameters were analyzed to establish native soil nitrogen concentrations present in potential LAD soil profiles. This information may be required to evaluate nitrate and ammonium assimilation capacities and the potential for leachate once pit water quantities and nitrogen inputs are known. Soil chemical and physical parameters used to further characterize LAD soils include cation exchange capacity, clay content, organic matter and calcium carbonate equivalent (Appendix A). These parameters provide an indication of the capacity of the soil profile to attenuate cations such as ammonium or metals that may be present in pit waters or process waters.

CASEYPEAK SERIES

The Caseypeak series consists of shallow, well-drained soils that formed in residuum derived from granite and other coarse-grained igneous rocks. These soils are on mountains and hills. Slopes are 25 to 60 percent. Mean annual precipitation is about 18 inches. Mean annual temperature is about 38° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Lithic Cryocrepts

TYPICAL PEDON: Caseypeak gravelly coarse sandy loam, bouldery, forested (colors are for dry soil unless otherwise noted).

Oi -- 1-1/2 to 0 inches; partially decomposed needles, twigs and leaves. Can range from 1/2 to 3 inches thick.

E -- 0 to 4 inches; light brownish gray (10YR 6/2) gravelly coarse sandy loam, brown (10YR 5/3) moist; moderate medium granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and fine and few medium pores; 20 percent pebbles; strongly acid (pH 5.2); clear wavy boundary. Can range from 4 to 6 inches thick.

Bw -- 4 to 9 inches; brown (10YR 5/3) very gravelly coarse sandy loam, brown (10YR 4/3) moist; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and few fine tubular and interstitial pores; 40 percent pebbles; very strongly acid (pH 5.0); gradual wavy boundary. Can range from 5 to 8 inches thick.

BC -- 9 to 12 inches; pale brown (10YR 6/3) very gravelly coarse sandy loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine, common fine and few medium roots; many very fine and few fine tubular and interstitial pores; 40 percent pebbles; moderately acid (pH 5.9); clear wavy boundary. Can range from 4 to 6 inches thick.

Cr -- 12 to 17 inches; light yellowish brown (2.5Y 6/4) decomposed granite bedrock (grus) that crushes to very gravelly loamy coarse sand; slightly acid (pH 6.5).

R -- 17+ inches; hard granite bedrock.

DESCRIPTION LOCATION: Jefferson County, Montana; 2,200 feet north and 550 feet east of the SW corner of Section 15, T. 6N, R. 3W.

TABLE 4-2
(continued)

SOIL SALVAGE DEPTHS AND RECLAMATION CONSTRAINTS
SANTA FE PACIFIC GOLD CORPORATION, ELKHORN PROJECT, JEFFERSON COUNTY, MONTANA

INTERPRETIVE GROUP	SERIES NAME	AVERAGE DEPTH OF SALVAGE			RECLAMATION CONSTRAINTS	AREA (acres)	EXTENT (percent)
		First Lift (inches)	Second Lift (inches)	Total (inches)			
Grassland Soils	SHOOK	12	12	24	Excessive coarse fragments and sand content for second lift if salvaged below 24 inches.	64.7	0.72
	SIEBEN	6	12	18	Excessive coarse fragments for second lift if salvaged below 18 inches.	13.5	0.15
	SIEBERELL	6	12	18	Excessive coarse fragments for second lift if salvaged below 18 inches.	5.5	0.06
	SILAS	12	24	36	No limitations other than second lift quality (OM, CEC) is better above 36 inch depth.	32.4	0.36
	SLOCUM	0	0	0	This soil is hydric and direct impacts would probably be avoided.	32.4	0.36
	TOLBERT	6	0	6	Lithic soil with excessive coarse fragments below a depth of 6 inches.	204.8	2.29
	TYPIC HAPLOBOROLLS	0	0	0	This soil is in drainage bottoms and intermingled with hydric soils.	42.5	0.47
	VARNEY	12	24	36	Deep soil of limited extent, no limitations.	6.5	0.07
	WINDHAM	6	12	18	Excessive coarse fragments if second lift is salvaged below 18 inches.	356.8	3.98
Forest Soils	BOBOWIC	24	0	24	Grus layer occurs at a depth of 21 inches and may be excessively sandy.	68.8	0.77
	CASEYPEAK	12	0	12	Grus layer occurs at a depth of 12 to 14 inches and may be excessively sandy.	667.0	7.45
	DRYADINE	12	0	12	Excessive coarse fragments if single lift salvaged below a depth of 24 inches.	279.7	3.12
	FRANCONI	36	0	36	Grus layer occurs at a depth of 32 to 40 inches and may be excessively sandy.	79.9	0.89
	HELMVILLE	18	0	18	Excessive coarse fragments if single lift salvaged below a depth of 18 inches.	1.3	0.01
	REDFERN	6	0	6	Lithic soil with excessive coarse fragments below a depth of 6 inches.	473.7	5.29
	TEPECREEK	24	0	24	Excessive coarse fragments if single lift salvaged below a depth of 24 inches.	543.2	6.06
	TIGERON	24	0	24	Excessive coarse fragments if single lift salvaged below a depth of 24 inches.	954.8	10.66
	TROPAL	6	0	6	Lithic soil with excessive coarse fragments below a depth of 6 inches.	360.7	4.03
	WARNEKE	12	0	12	Lithic soil, bedrock encountered at an average depth of 12 inches.	92.5	1.03
	WHITECOW	12	0	12	Excessive coarse fragments if single lift salvaged below a depth of 12 inches.	200.6	2.24

CASEYPEAK (2) SERIES

The Caseypeak (2) series consists of shallow, well-drained soils that formed in residuum derived from granite and other coarse-grained igneous rocks. These soils are on mountains and hills. Slopes are 25 to 60 percent. Mean annual precipitation is about 18 inches. Mean annual temperature is about 38° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Lithic Cryocrepts

TYPICAL PEDON: Caseypeak gravelly coarse sandy loam, bouldery, forested (colors are for dry soil unless otherwise noted).

Oi -- 2 to 0 inches; partially decomposed needles, twigs and leaves. Can range from 1/2 to 3 inches thick.

E -- 0 to 5 inches; very dark grayish brown (10YR 3/2) gravelly coarse sandy loam, black (10YR 2/1) moist; moderate medium granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and fine and few medium pores; 20 percent pebbles; neutral (pH 7.0); clear wavy boundary. Can range from 4 to 6 inches thick.

Bw -- 5 to 14 inches; dark grayish brown (10YR 4/2) very gravelly coarse sandy loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and few fine tubular and interstitial pores; 40 percent pebbles; mildly alkaline (pH 7.7); gradual wavy boundary. Can range from 5 to 8 inches thick.

Cr -- 14 to 18 inches; brown (10YR 4/3) decomposed diorite bedrock (grus) that cruses to very gravelly loamy coarse sand; mildly alkaline (pH 7.7).

R -- 18+ inches; hard granite bedrock.

DESCRIPTION LOCATION: Jefferson County, Montana; 1,500 feet south and 600 feet east of the NW corner of Section 11, T. 6N, R. 3W.

TABLE 4-2 SOIL SALVAGE DEPTHS AND RECLAMATION CONSTRAINTS
SANTA FE PACIFIC GOLD CORPORATION, ELKHORN PROJECT, JEFFERSON COUNTY, MONTANA

INTERPRETIVE GROUP	SERIES NAME	AVERAGE DEPTH OF SALVAGE			RECLAMATION CONSTRAINTS	AREA (acres)	EXTENT (percent)
		First Lift (inches)	Second Lift (inches)	Total (inches)			
Grassland Soils	ADEL	12	24	36	Deep soil with no limitations except location in drainage bottoms.	48.1	0.54
	BEAVERELL	6	6	12	Excessive coarse fragments for second lift if salvaged below 12 inches.	5.9	0.07
	BROWNSHUT	12	12	24	Excessive coarse fragments for second lift if salvaged below 24 inches.	127.3	1.42
	CLASOIL	12	24	36	Deep soil of limited extent, no limitations.	5.5	0.06
	CRAGO	6	12	18	Excessive coarse fragments for second lift if salvaged below 18 inches.	24.4	0.27
	CUMULIC HAPLAQUOLLS	0	0	0	This soil is hydric and direct impacts would probably be avoided.	63.7	0.71
	FAIRWAY	12	12	24	Groundwater occurs at 30 inches, this soil is of limited extent.	2.1	0.02
	FLUVAQUENTIC HAPLAQUOLLS	0	0	0	This soil is intermingled with hydric soils in drainage bottoms.	84.9	0.95
	HANSON	12	0	12	Excessive coarse fragments below a depth of 6 inches prohibit salvage of second lift.	119.5	1.33
	HILGER	6	6	12	Excessive coarse fragments for second lift if salvaged below 12 inches.	187.7	2.10
	JUDELL	12	24	36	No limitations other than second lift quality (structure, OM) is better above 36 inch depth.	12.3	0.14
	LAP	6	6	12	Excessive coarse fragments for second lift if salvaged below 12 inches.	255.8	2.86
	LIBEG	12	24	36	No limitations other than second lift quality (structure, OM, CEC) is better above 36 inch depth.	286.9	3.20
	MAIDEN	6	0	6	Excessive coarse fragments below a depth of 12 inches prohibit salvage of second lift.	348.3	3.89
	MARTINSDALE	12	24	36	Excessive sodium (SAR 23) and elevated pH (8.6) below a depth of 36 inches	245.2	2.74
	NESTLEY	12	12	24	Excessive sand content for second lift if salvaged below 12 inches.	1.1	0.01
	NIEMAN	6	0	6	Excessive coarse fragments below a depth of 6 inches prohibit salvage of second lift.	436.7	4.88
	PENSORE	6	0	6	Lithic soil with excessive coarse fragments below a depth of 6 inches prohibit second lift.	1.0	0.01
	SAWBUCK	12	24	36	Deep soil of limited extent, no limitations.	11.0	0.12
	SHAWMUT	6	12	18	Excessive coarse fragments for second lift if salvaged below 18 inches.	863.2	9.64

CLASOIL SERIES

The Clasoil series consists of very deep, well-drained soils that formed in alluvium derived from granitic and other coarse-grained igneous rocks. These soils are on alluvial fans and terraces. Slopes are 2 to 35 percent. Mean annual precipitation is about 17 inches. Mean annual air temperature is about 40° F.

TAXONOMIC CLASS: Fine-loamy, mixed Typic Argiborolls

TYPICAL PEDON: Clasoil gravelly loam, bouldery in rangeland (colors are for dry soil unless otherwise noted).

A1 -- 0 to 5 inches; very dark grayish brown (10YR 3/2) gravelly loam, black (10YR 2/1) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine and medium roots; many very fine and fine interstitial pores; 5 percent cobbles, 10 percent pebbles; slightly acid (pH 6.2); clear smooth boundary.

A2 -- 5 to 13 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark gray (10YR 3/1) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; many very fine and few fine and medium roots; many very fine and common fine pores; 5 percent cobbles, 25 percent pebbles; slightly acid (pH 6.2); clear smooth boundary. (Combined thickness of A horizons is 7 to 15 inches)

Bt1 -- 13 to 24 inches; light yellowish brown (10YR 6/4) gravelly sandy clay loam, yellowish brown (10YR 5/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; common very fine and few fine and medium roots; common very fine and fine pores; common thin clay films on faces of peds and bridging between sand grains; 5 percent cobbles; 15 percent pebbles; neutral (pH 6.7); clear smooth boundary.

Bt2 -- 24 to 34 inches; light yellowish brown (2.5Y 6/4) cobbly sandy clay loam, yellowish brown (10YR 5/4) moist; moderate medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; common very fine and few fine and medium roots; common very fine and few fine pores; common thin clay films on faces of peds and bridging between sand grains; 20 percent cobbles; 10 percent pebbles; neutral (pH 6.7); clear smooth boundary. (Combined thickness of Bt horizons is 8 to 24 inches).

BC -- 34 to 60 inches; light yellowish brown (10YR 6/4) very cobbly loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; 25 percent cobbles; 15 percent pebbles; neutral (pH 6.6).

TYPE LOCATION: Jefferson County, Montana; 500 feet north and 1,000 feet east of the SW corner of Sec. 13, T. 9N., R. 2 W.

4.1.4 Hydrologic Features

Hydrologic features are also used to assess the suitability of project area soils for reclamation or other purposes. Available water capacity (AWC) for example, is a measure (inches of water per foot of soil) of the capacity of the soil to store and release plant available water. AWC and drainage class are also important factors used to evaluate the suitability of soils for waste water disposal. The suitability of soils for Land Application Disposal (LAD) will be addressed in greater detail under Section 4.2 of this report. The Hydrologic Group relates soil texture and surface conditions (vegetative cover) and groups soils according to runoff potential, and is used in equations to calculate runoff. Hydrologic groups are used in the design of surface water control structures at mining facilities. Soils identified as hydric or closely associated with hydric soils in the project area will most likely be avoided and protected from mining impacts. The sensitive nature of hydric soil sites, combined with significant site operational constraints, would preclude consideration for disturbance. Therefore, no salvage or salvage depth considerations are recommended for these soils.

4.1.5 Slope

Although slope does not necessarily limit the quality of soils for a specific use, it may limit the salvageability of soils from an operational standpoint. The DSL suggests that soils on slopes greater than 50 percent may be unsuitable for salvage. For the baseline soils investigation report, slope is not specifically considered a limiting factor. Once mine plans identify specific areas of disturbance and the types of equipment that will be available for soil salvage operations, the effect of slope on soil salvage can be more appropriately evaluated.

4.2 RECOMMENDED SOIL SALVAGE DEPTHS

Utilizing the criteria, factors and guidelines discussed in the previous sections, the depth of soil salvage, for each soil series in the Elkhorn Project area was determined. In Table 4-2, project area soils are organized according to grassland or forest land interpretation groups and the depth of salvage specified for each lift (first, second or single). Following salvage depth recommendations is a brief description of the factor or factors (reclamation constraints) that limited the depth of salvage. The total depth of salvage for any given soil was limited to 36

CRAGO SERIES

The Crago series consists of very deep, well-drained soils that formed in alluvium or colluvium derived mainly from limestone or basal conglomerate. These soils are on alluvial fans, stream terraces, and hills. Slopes are 0 to 75 percent. Mean annual precipitation is about 12 inches. Mean annual temperature is about 43° F.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic Borollic Calciorthids

TYPICAL PEDON: Crago gravelly loam, in grassland (colors are for dry soil unless otherwise noted).

A -- 0 to 5 inches; grayish brown (10YR 5/2) gravelly heavy loam, dark grayish brown (10YR 4/2) moist; moderate fine and medium granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many fine pores; 20 percent pebbles; slightly effervescent; moderately alkaline (pH 8.0); clear boundary. (2 to 5 inches thick)

Bk1 -- 4 to 9 inches; light brownish gray (2.5Y 6/2) gravelly heavy loam, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; few fine pores; 25 percent pebbles; continuous prominent lime crusts on undersides of pebbles; disseminated lime in soil matrix; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary. (2 to 6 inches thick)

Bk2 -- 9 to 14 inches; white (2.5Y 8/2) gravelly clay loam, light yellowish brown (2.5Y 6/4) moist; weak medium subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; few fine roots; few fine pores; 35 percent pebbles; disseminated lime in soil matrix; many fine masses of lime; continuous prominent lime crusts on underside of pebbles; violently effervescent; moderately alkaline (pH 8.4); diffuse boundary. (0 to 6 inches thick)

Bk3 -- 14 to 26 inches; white (2.5Y 8/2) extremely gravelly clay loam, light yellowish brown (2.5Y 6/4) moist; massive; hard, very friable, slightly sticky and slightly plastic; few roots; 5 percent cobbles, 55 percent pebbles; disseminated lime in soil matrix; many fine masses of lime; continuous prominent lime crusts on pebbles with some lime cementation between some pebbles; violently effervescent; moderately alkaline (pH 8.4); diffuse wavy boundary. (10 to 16 inches thick)

Bk4 -- 26 to 50 inches; pale yellow (2.5Y 7/4) extremely gravelly loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; few fine roots; about 65 percent pebbles; disseminated lime in soil matrix; continuous distinct lime crusts on pebbles; some lime cementation between individual pebbles; violently effervescent; moderately alkaline (pH 8.4); diffuse boundary. (20 to 30 inches thick)

There are no salvage limitations due to soil pH and many of the soils in the project area contain an abundance of carbonates. The acid base account for Elkhorn Project soils suitable for salvage ranges from 7 to 732 tons of calcium carbonate per 1,000 tons of soil. This is desirable from a reclamation stand point as these soils will provide suitable cover for potentially acid forming waste rock materials that may be produced during mining operations.

Other chemical, physical and morphological factors considered when determining the depth of salvage and quality of soil include soil structure, texture, and cation exchange capacity. If coarse fragments or depth to bedrock did not limit the depth of salvage, particularly for the deeper non-skeletal soils, structure and cation exchange capacity were considered. Subsoil materials with structure have better reclamation qualities than subsoil materials with massive structure because they are less susceptible to compaction and erosion. Cation exchange capacity tends to decrease with depth in project area soils and is a quality criterion (soil fertility) for the suitability of soil materials used as a plant growth medium. In soils derived from diorite or quartz monzonite, excessive sand was sometimes encountered in the Cr horizon overlying bedrock and this limited the depth of salvage.

4.1.3 Soil Capability and Erosion

Capability classes indicate the suitability of the soil for dryland or irrigated crop production, and identify certain limitations to productivity such as slope and erodibility (Table 4-1). Erosion factors (Table 4-1) include the soil erodibility factor (K), soil loss tolerance (T factor), and the wind erodibility group (WEG). The K factor is a measure of the susceptibility of the soil to particle detachment and transport by rainfall. The T factor is the maximum rate of annual soil erosion (measured in tons per acre) that will permit crop productivity to be economically sustained. The K and T factors are used in the Universal Soil Loss Equation (USLE) to predict soil losses. The WEG is a collection of soils with similar properties effecting resistance to wind erosion and the wind erodibility index (I) provides an estimate of the potential loss of soil by wind (measured in tons per acre per year). Erosion factors are used to identify potential limitations or special management considerations for soils that may be utilized for reclamation. Erosion factors are also used in the design and evaluation of surface water control structures at mine facilities.

CRAGO SERIES (Continued)

2C -- 50 to 60 inches; pale yellow (2.5Y 7/4) extremely gravelly loamy sand, light olive brown (2.5Y 5/4) moist; massive; hard, very friable, nonsticky and nonplastic; 60 to 70 percent pebbles; disseminated lime; strongly effervescent; moderately alkaline (pH 8.4);

TYPE LOCATION: Musselshell County, Montana; 100 feet north and 1,000 feet west of the SW corner of Section 12, T. 9N, R. 25E.

4.1.1 Interpretive Groups

Interpretive groups identify the range site or habitat type for each soil. For the Elkhorn Project soil inventory, range site and habitat type are used to determine which soils will be evaluated for two lift versus single lift salvage. In Table 4-1, a simplification of SCS range site and habitat type interpretive data identify grassland soils versus forest soils.

The reclamation of rangeland or grassland will be more successful if grassland soils are salvaged in two lifts. This concentrates organic matter, microorganisms and seeds and reduces rock fragments in the topsoil, conditions more conducive to the establishment of grasses. By contrast, coniferous tree species generally favor a skeletal, well-drained soil and do not tolerate competition from grasses during establishment. Therefore a single lift salvage is more desirable for the forest soils.

4.1.2 Soil Chemical, Physical and Morphological Factors

Skeletal and lithic soils occur extensively throughout the Elkhorn Project area. The coarse fragment content of soils is a primary limiting factor in the depth of soil salvage. Coarse fragment content estimates made from profile descriptions were considered more reliable than laboratory measurements because it was often difficult to obtain a representative sample size from genetic horizons. A coarse fragment content of 50 percent by volume or 66 percent by weight (Table 2-2) were limiting criteria used to determine appropriate depths of salvage for two lift and single lift scenarios. Rock outcrop and rock rubbleland, which are a significant component of soils mapped in the project area are not considered for salvage or reclamation purposes.

Organic matter (OM) content was the primary parameter used to determine the optimal depth to salvage the first lift for grassland soils. Organic matter is a recognized soil quality criterion (Coppinger et al. 1993) used to evaluate the optimal salvage depth for topsoil. For Elkhorn Project soils, genetic horizons with an OM content less than 1 to 1.5 percent were not included in the first lift.

DRYADINE SERIES

The Dryadine series consists of moderately deep, well-drained soils that formed in residuum derived from limestone. These soils are on mountaintops. Slopes are 2 to 25 percent. Mean annual precipitation is about 35 inches, and mean annual air temperature is about 36°F.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic Typic Cryochrepts

TYPICAL PEDON: Dryadine flaggy silt loam, forested, colors are for dry soil unless otherwise noted.

Oi -- 1 to 0 inches; pine needles, twigs and cones.

A -- 0 to 6 inches; very dark gray (10YR 3/1) flaggy silt loam (10YR 2/1) moist; moderate very fine granular structure; soft, very friable, slightly sticky and plastic; many fine and very fine roots and common medium and coarse roots; 15 percent angular cobbles and 10 percent flat angular pebbles; mildly alkaline (pH 7.5); abrupt wavy boundary. Can range from 2 to 5 inches thick.

Bw -- 6 to 16 inches; dark gray (10YR 4/1) extremely flaggy silt loam, black (10YR 2/1) moist; moderate very fine subangular blocky structure parting to moderate very fine granular; soft, very friable, slightly sticky and slightly plastic; many coarse, medium, fine, and very fine roots; 35 percent flat angular pebbles and 30 percent angular cobbles; strongly effervescent; mildly alkaline (pH 7.6); gradual wavy boundary. Can range from 3 to 10 inches thick.

Bk -- 16 to 29 inches; grayish brown (10YR 5/2) extremely flaggy silt loam, dark grayish brown (10YR 4/2) moist; moderate very fine subangular blocky structure parting to weak very fine granular; soft, very friable, slightly sticky and slightly plastic; common fine and very fine roots and few coarse and medium roots; many fine and very fine pores and common medium pores; 50 percent flagstones and 35 percent flat angular pebbles; strongly effervescent; mildly alkaline (pH 7.8); diffuse irregular boundary. Can range from 10 to 15 inches thick.

C -- 29 to 40 inches; grayish brown (10YR 5/2) extremely flaggy silt loam, dark grayish brown (10YR 4/2) moist; weak very fine granular structure; soft, very friable, slightly sticky and slightly plastic; few fine and very fine roots; 65 percent flagstones and 30 percent flat angular pebbles; strongly effervescent; mildly alkaline (pH 7.8); abrupt wavy boundary. Can range from 9 to 18 inches thick.

R -- 40 inches; very hard fractured limestone. (fracture intervals exceed 8 inches)

DESCRIPTION LOCATION: Jefferson County, Montana; about 400 feet west and 1,300 feet south of the NE corner of Section 11, T. 6N, R. 3W.

TABLE 4-1 SOIL SUITABILITY INTERPRETATION DATA
SANTA FE PACIFIC GOLD CORPORATION, ELKHORN PROJECT, JEFFERSON COUNTY, MONTANA

SERIES NAME	INTERPRETIVE GROUP		MORPHOLOGY		CAPABILITY AND EROSION			HYDROLOGIC FEATURES				
	Average Depth to Bedrock (inches)	Average Depth to 50% C.F. (inches)	Capability Class*	Erosion Factors	Erosion Est	Wind	I (U/acre/yr)	Total Available H ₂ O(inches)	Drainage Class	Hydrologic Group	Flood Hazard	Hydric
ADEL	60+	60+	6e/6e	0.28	5	6	48	7.5	well	B	rare	no
BEAVERELL	60+	11	7s/7s	0.05	2	6	48	2.0	well	B	none	no
BOBOWIC	43	43	7e/-	0.10	3	4L	86	2.5	well	B	none	no
BROWNSHUT	60	60	4s/4s	0.24	3	4L	86	4.5	well	B	none	no
CASEYPEAK	18	18	7e/-	0.08	1	8	0	1.0	well	D	none	no
CLASOIL	60	60	7e/-	0.24	5	6	48	9.0	well	B	none	no
CRAGO	60	14	4e/4e	0.24	3	4L	86	5.0	well	B	none	no
CUMULIC HAPLAQUOLLS	60+	60+	5w/5w	0.43	3	6	48	10.0	poor	C	occasional	yes
DRYADINE	40	6	7e/-	0.15	2	4L	86	3.0	well	C	none	no
FAIRWAY	60	60	3w/3w	0.32	5	6	48	9.5	poor	C	rare	no
FLUVAQUENTIC HAPLAQUOLLS	60+	60+	6w/6w	0.32	4	6	48	8.0	poor	C	rare	no
FRANCONI	36	36	7e/7e	0.15	2	8	0	3.0	well	B	none	no
HANSON	60+	14	4e/4e	0.17	3	4L	86	5.5	well	B	none	no
HELMVILLE	60+	18	7e/-	0.10	3	8	0	4.0	well	C	none	no
HILGER	60+	9	7e/7e	0.15	3	8	0	8.5	well	B	none	no
JUDELL	60+	54	4e/4e	0.24	5	4L	86	1.0	well	B	none	no
LAP	19	5	7e/7e	0.15	1	4L	86	4.0	well	D	none	no
LIBEG	60+	60+	7e/-	0.15	3	6	48	2.5	well	B	none	no
MAIDEN	26	4	6e/6e	0.15	2	4L	86	8.0	well	B	none	no
MARTINSDALE	60+	60+	4e/4e	0.37	5	6	48	4.0	poor	B	rare	no
NESTLEY	60+	60+	4w/4w	0.32	2	5	56	4.0	well	C	none	no
NIEMAN	12	0	7e/-	0.15	1	6	48	1.0	well	D	none	no
PENSORE	15	4	7s/7s	0.20	1	4L	86	2.0	well	D	none	no
REDFERN	13	0	7e/-	0.05	1	6	48	1.0	well	D	none	no
SAWBUCK	60+	15	7e/7e	0.15	2	5	56	4.0	well	B	none	no
SHAWMUT	60+	12	7e/-	0.20	3	6	48	6.0	well	B	none	no
SHOOK	36+	28	6e/6e	0.32	2	5	56	3.0	well	C	none	no
SIEBEN	60+	17	4s/4s	0.15	3	5	56	5.0	well	B	none	no
SIEBERELL	60+	11	6s/6s	0.15	3	6	48	2.5	well	B	none	no
SILAS	60+	60+	6w/6w	0.37	5	5	56	6.5	poor	C	none	yes
SLOCUM	60+	60+	6w/6w	0.37	2	5	56	2.5	well	B	none	no
TEPECREEK	52	28	7e/-	0.10	3	8	0	3.5	well	B	none	no
TIGERON	60+	20	7e/-	0.10	3	6	48	1.0	well	D	none	no
TOLBERT	12	5	7e/-	0.15	1	6	48	1.0	well	D	none	no
TROPAL	15	4	7e/7e	0.15	1	4L	86	1.0	well	D	none	no
TYPIC HAPLOBOROLLS	60+	60+	4e/4e	0.32	3	6	48	8.0	well	B	none	no
VARNEY	60+	60+	6e/-	0.10	1	4L	86	1.0	well	D	none	no
WARNEKE	12	7	7e/-	0.10	1	4L	86	4.0	well	B	none	no
WHITECOW	60+	60+	7e/-	0.15	3	4L	86	5.0	well	B	none	no
WINDHAM	60+	11	6e/-	0.24	2	4L	86	5.0	well	B	none	no

*Capability Class/Type of Limitation

Capability Class designated 1 (few commercial crop limitations) through 7 (unsuitable for commercial crops, limited to recreation/wildlife/habitat)

Type of Limitation: e = erosion, w = wetness, s = shallow, stony, droughty

DRYADINE (2) SERIES

The Dryadine (2) series consists of moderately deep, well-drained soils that formed in residuum derived from limestone. These soils are on mountaintops. Slopes are 2 to 25 percent. Mean annual precipitation is about 35 inches, and mean annual air temperature is about 36°F.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic Typic Cryochrepts

TYPICAL PEDON: Dryadine flaggy silt loam, forested, colors are for dry soil unless otherwise noted.

Oi -- 2 inches to 1-inch; pine needles, twigs and cones.

Oe -- 1 to 0-inch; partly weathered organic matter.

A -- 0 to 4 inches; very dark grayish brown (10YR 3/2) flaggy silt loam, black (10YR 2/1) moist; fine platy parting; moderate very fine granular structure; soft, very friable, slightly sticky and plastic; many fine and very fine roots; 15 percent angular cobbles and 15 percent pebbles; neutral (pH 7.3); abrupt wavy boundary. Can range from 2 to 5 inches thick.

Bw -- 4 to 11 inches; grayish brown (10YR 5/2) extremely flaggy silt loam, very dark grayish brown (10YR 3/2) moist; very fine weak subangular blocky structure parting; soft, very friable, slightly sticky and slightly plastic; many fine and very fine roots; 25 percent flat angular pebbles and 30 percent angular cobbles; strongly effervescent; mildly alkaline (pH 7.6); gradual wavy boundary. Can range from 3 to 10 inches thick.

Bk -- 11 to 24 inches; very pale brown (10YR 7/3) extremely flaggy silt loam, very pale brown (10YR 7/3) moist; moderate very fine subangular blocky structure parting; soft, very friable, slightly sticky and slightly plastic; common fine and very fine roots; many fine and very fine pores and common medium pores; 40 percent flagstones and 20 percent angular cobbles; violently effervescent; moderately alkaline (pH 7.9); diffuse irregular boundary. Can range from 10 to 15 inches thick.

C -- 24 to 40 inches; very pale brown (10YR 7/3) extremely flaggy silt loam, very pale brown (10YR 7/3) moist; massive; soft, very friable, slightly sticky and slightly plastic; few fine and very fine roots; 3-5 percent pebbles, 50 percent flagstones and 30 percent angular cobbles; violently effervescent; strongly alkaline (pH 8.7); abrupt wavy boundary. Can range from 9 to 18 inches thick.

R -- 40+ inches; very hard fractured limestone (Jefferson dolomite)

DESCRIPTION LOCATION: Jefferson County, Montana; about 2,350 feet south and 2,200 feet east of the NW corner of Section 14, T. 6N, R. 3W.

4.0 USE AND MANAGEMENT OF ELKHORN PROJECT SOILS

Elkhorn Project area soils will be subject to multiple uses. In areas of the project where mining-related activities result in a disturbance of the land, soils will be salvaged and utilized for reclamation purposes. The construction of mine facilities (roads, buildings, diversions, tailings impoundments, etc.), and open pit mining are examples of disturbances which will require the salvage of soils. Some areas within the project may be utilized for the disposal of excess mine water. Much of the land in the project area may not be disturbed and will probably be managed as rangeland or wildlife habitat. This section of the baseline soil report provides information needed to determine the suitability of the Elkhorn Project soils for a given use.

4.1 FACTORS USED TO DETERMINE SOIL SALVAGE DEPTHS AND RECLAMATION SUITABILITY

Information on the morphology of soils obtained from detailed profile descriptions (Section 3.3) and the results of chemical and physical laboratory analysis performed on genetic soil horizons (Appendix A) are the primary data used to evaluate soil salvage depths and reclamation suitability. Structure, thickness of genetic horizons, depth and abundance of roots, abundance of rock fragments, and depth to bedrock are important morphological factors used to determine the depth of salvage. Soil pH, organic matter content and texture are the primary chemical and physical parameters used to evaluate the quality of salvageable soil. Other soil factors used to evaluate the depth of salvage and the suitability of project area soils for reclamation and other purposes were obtained from the SCS (soil interpretation data). Interpretations for Elkhorn Project area soils are summarized in Table 4-1. In Table 4-1, information is organized according to four categories including interpretive groups (range site and habitat type), soil morphology, capability and erosion (dryland/irrigated capability and K, T, WEG and I factors), and hydrologic features (WHC, drainage, hydrologic group, flood hazard and hydric). All relevant morphological, chemical and physical data were evaluated relative to DSL unsuitability criteria (Table 2-2) or other guidelines (DSL 1983).

FAIRWAY SERIES

The Fairway series consists of very deep, somewhat poorly drained soils that formed in alluvium. These soils are on flood plains. Slopes are 0 to 4 percent. Mean annual precipitation is about 12 inches. Mean annual temperature is about 43° F.

TAXONOMIC CLASS: Fine-loamy, mixed Fluvaquent Haploborolls

TYPICAL PEDON: Fairway silt loam, cultivated (colors are for dry soil unless otherwise noted).

A1 -- 0 to 8 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate very fine and fine granular structure; slightly hard, friable, sticky and slightly plastic; common very fine, medium, and coarse roots; disseminated lime; strongly effervescent; mildly alkaline (pH 7.6); clear smooth boundary. (5 to 8 inches thick)

A2 -- 8 to 15 inches; grayish brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, sticky and slightly plastic; common very fine, medium, and coarse roots; common very fine tubular and interstitial pores; disseminated lime; strongly effervescent; mildly alkaline (pH 7.8); clear smooth boundary. (5 to 10 inches thick)

Bk -- 15 to 30 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure parting to weak coarse subangular blocky; hard, friable, sticky and slightly plastic; common very fine, medium, and coarse roots; common very fine tubular and interstitial pores; few thin grayish brown (2.5Y 5/2) layers of soil, very dark grayish brown (2.5Y 3/2) moist; few fine seams and masses of lime; strongly effervescent; mildly alkaline (pH 7.8); clear smooth boundary. (10 to 20 inches thick)

Bg -- 30 to 45 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; many fine and medium prominent reddish brown (5YR 4/4) mottles, moist; massive; friable, sticky and plastic; disseminated lime; slightly effervescent; neutral (pH 7.2); gradual smooth boundary. (10 to 24 inches thick)

2Cg -- 45 to 60 inches; light brownish gray (2.5Y 6/2) sand, dark grayish brown (2.5Y 4/2) moist; few fine and medium prominent dark brown (7.5YR 4/4) mottles, moist; single grain; loose, nonsticky and nonplastic; neutral (pH 7.2); (0 to 20 inches thick)

TYPE LOCATION: Lewis and Clark County, Montana; about 2,100 feet north and 2,400 feet east of the SW corner of Section 15, T. 10N, R. 3W.

3.4 LABORATORY ANALYTICAL RESULTS

The results of laboratory analyses performed on genetic horizons of the soil series sampled in the project area are in Appendix A. A total of 137 samples from 31 soil series were analyzed. The results of chemical and physical analysis performed on project area soils are used in conjunction with morphological information provided in the detailed soil profile descriptions to determine salvage depths and the suitability of soils for reclamation, and other uses. The pH of project area soils ranged from 5.0 to 8.6. Arsenic and metals were not analyzed or considered in the evaluation of salvage and reclamation suitability since pH values for all soil horizons were above 5 (Hydrometrics, 1993). Samples were analyzed for all other parameters listed in Table 2-2. The interpretation of chemical and physical analysis results is discussed in Section 4.1.2.

FRANCONI SERIES

The Franconi series consists of moderately deep, well-drained soils that formed in colluvium or residuum derived from granite bedrock. These soils are on dissected bedrock floored plains, hills and mountains. Slopes are 4 to 60 percent. Mean annual precipitation is about 22 inches. Mean annual air temperature is about 38° F.

TAXONOMIC CLASS: Fine-loamy, mixed Glossic Cryoboralfs

TYPICAL PEDON: Franconi gravelly sandy clay loam, stony, forested (colors are for dry soil unless otherwise noted).

Oi -- 1 to 0 inches; partially decomposed needles, twigs and leaves. Can range from 1/2 to 3 inches thick.

E -- 0 to 6 inches; very dark grayish brown (10YR 3/2) gravelly sandy clay loam, very dark gray (10YR 3/1) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine few medium roots; many very fine and fine and medium pores; 5 percent cobbles and 15 percent pebbles; slightly acid (pH 6.3); clear smooth boundary. Can range from 3 to 8 inches thick.

E/Bt -- 6 to 11 inches; very dark grayish brown (10YR 3/2) gravelly sandy clay loam, very dark gray (10YR 3/1) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; many very fine and few fine interstitial and tubular pores; few faint clay films bridging sand grains in Bt part; 20 percent pebbles; neutral (pH 6.7); clear smooth boundary. Can range from 0 to 8 inches thick.

Bt/E -- 11 to 17 inches; dark brown (10YR 3/3) gravelly sandy clay loam, very dark brown (10YR 2/2) moist; moderate medium and coarse prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and few fine and medium roots; many very fine and few fine interstitial and tubular pores; many faint clay films on faces of peds and bridging sand grains in Bt part; 20 percent pebbles; neutral (pH 6.7); clear wavy boundary. Can range from 6 to 10 inches thick.

Bt1 -- 17 to 24 inches; dark yellowish brown (10YR 4/4) gravelly clay loam, brown (10YR 4/3) moist; moderate medium and coarse prismatic structure parting to strong fine and medium subangular blocky; hard, firm, sticky and slightly plastic; common very fine and few fine and medium roots; many very fine and few fine interstitial and tubular pores; many faint clay films on faces of peds and bridging sand grains; 5 percent cobbles and 25 percent pebbles; neutral (pH 6.7); clear wavy boundary.

WINDHAM SERIES

The Windham series consists of very deep, well-drained soils that formed in very gravelly alluvium and colluvium derived mainly from limestone. These soils are on alluvial fans, stream terraces, escarpments, and mountains. Slopes are 0 to 85 percent. Mean annual precipitation is about 16 inches. Mean annual air temperature is about 41° F.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic, Typic Calciborolls

TYPICAL PEDON: Windham gravelly clay loam, cultivated (colors are for dry soil unless otherwise noted).

A -- 0 to 7 inches; dark grayish brown (10YR 4/2) gravelly clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; 15 percent limestone pebbles; continuous distinct lime casts on underside of pebbles; slightly effervescent; slightly acid (pH 6.2); clear wavy boundary. Can range from 5 to 10 inches thick.

Bk1 -- 7 to 11 inches; pale brown (10YR 6/3) gravelly clay loam, brown (10YR 5/3) moist; moderate fine and very fine subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine pores; 20 percent limestone pebbles; continuous prominent casts and pendants on underside of pebbles; disseminated lime; violently effervescent; mildly alkaline (pH 7.7); clear wavy boundary. Can range from 2 to 7 inches thick.

Bk2 -- 11 to 17 inches; white (10YR 8/2) extremely gravelly loam, very pale brown (10YR 7/3) moist; massive; hard, friable, slightly sticky and nonplastic; many fine and very fine roots; many fine and very fine pores; 55 percent limestone pebbles; 5 percent limestone cobbles; common fine masses of lime; continuous prominent lime casts and pendants on underside of pebbles and cobbles; disseminated lime; violently effervescent; moderately alkaline (pH 7.9); diffuse wavy boundary. Can range from 13 to 26 inches thick.

Bk3 -- 17 to 60 inches; very pale brown (10YR 7/4) extremely gravelly loam, light yellowish brown (10YR 6/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; common fine and very fine roots; common to few fine and very fine pores; 60 percent limestone pebbles, 10 percent cobbles; common fine masses of lime; continuous distinct lime casts and pendants on underside of pebbles and cobbles; disseminated lime; violently effervescent; moderately alkaline (pH 8.3).

DESCRIPTION LOCATION: Jefferson County, Montana; 1,900 feet north and 450 feet west of the SE corner of Section 10, T. 5N, R. 3W.

FRANCONI SERIES (Continued)

Bt2 -- 24 to 32 inches; brown (10YR 4/3) gravelly clay loam, dark brown (1.0YR 3/3) moist; weak coarse prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine and few fine interstitial and tubular pores; common faint clay films on faces of peds and bridging sand grains; 20 percent pebbles; neutral (pH 6.7); clear smooth boundary. Combined thickness of Bt horizons can range from 13 to 25 inches.

Cr -- 32+ inches; olive brown (2.5Y 4/3) decomposed diorite bedrock (grus) that crushes to very gravelly coarse sand; neutral (pH 7.2); gradual wavy boundary.

DESCRIPTION LOCATION: Jefferson County, Montana; 1,800 feet north and 100 feet west of the SE corner of Section 10, T. 6N, R. 3W.

WHITECOW SERIES

The Whitecow series consists of very deep, well-drained soils that formed in alluvium and colluvium from limestone. These soils are on mountains, hills, and alluvial fans. Slopes are 0 to 80 percent. Mean annual precipitation is about 20 inches. Mean annual air temperature is about 41° F.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic, frigid Typic Ustochrepts

TYPICAL PEDON: Whitecow gravelly loam, woodland (colors are for dry soil unless otherwise noted).

O -- 1 inch to 0; undecomposed forest litter of needles and twigs.

A -- 0 to 3 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak medium and fine granular structure; soft, very friable, slightly sticky and slightly plastic; common fine roots and few medium roots; 25 percent subrounded pebbles; slightly effervescent; mildly alkaline (pH 7.5); clear smooth boundary. Can range from 2 to 4 inches thick.

Bk1 -- 3 to 7 inches; grayish brown (10YR 5/2) very gravelly loam, dark grayish brown (10YR 4/2) moist; weak fine angular structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; common fine pores; 40 percent angular pebbles; 5 percent angular cobbles; continuous faint lime crusts on undersides of rock fragments; violently effervescent; mildly alkaline (pH 7.5); clear boundary. Can range from 3 to 15 inches thick.

Bk2 -- 7 to 17 inches; light brownish gray (2.5Y 6/2) very gravelly heavy loam, light olive brown (2.5Y 5/4) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few or common fine roots; common fine pores; 60 percent angular pebbles; 5 percent angular cobbles; continuous distinct lime coats on rock fragments; disseminated lime; violently effervescent; mildly alkaline (pH 7.8); gradual boundary. Can range from 6 to 20 inches thick.

Bk3 -- 17 to 30 inches; light brownish gray (2.5Y 6/2) extremely gravelly loam, light olive brown (2.5Y 5/4) moist; weak fine and medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few fine roots; few fine pores; 70 percent angular pebbles, 5 percent angular cobbles; continuous distinct lime coats on rock fragments; violently effervescent; moderately alkaline (pH 8.2); gradual boundary. Can range from 15 to 25 inches thick.

Bk4 -- 30 to 60 inches; light brownish gray (2.5Y 6/2) extremely gravelly loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable, sticky and slightly plastic; few fine roots; few fine pores; 70 percent angular pebbles, 5 percent angular cobbles; violently effervescent; moderately alkaline (pH 8.1).

DESCRIPTION LOCATION: Jefferson County, Montana; 700 feet east and 100 feet north of the SW corner of Section 2, T. 5N, R. 3W.

FRANCONI (2) SERIES

The Franconi (2) series consists of moderately deep, well-drained soils that formed in colluvium or residuum derived from granite bedrock. These soils are on dissected bedrock floored plains, hills and mountains. Slopes are 4 to 60 percent. Mean annual precipitation is about 22 inches. Mean annual air temperature is about 38° F.

TAXONOMIC CLASS: Fine-loamy, mixed Glossic Cryoboralfs

TYPICAL PEDON: Franconi gravelly sandy clay loam, stony, forested (colors are for dry soil unless otherwise noted).

Oi -- 1 to 0 inches; partially decomposed needles, twigs and leaves. Can range from 1/2 to 3 inches thick.

E -- 0 to 8 inches; grayish brown (10YR 5/2) gravelly sandy clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine few medium roots; many very fine and fine and medium pores; 5 percent cobbles and 15 percent pebbles; slightly acid (pH 6.1); clear smooth boundary. Can range from 3 to 8 inches thick.

E/Bt -- 8 to 14 inches; grayish brown (10YR 5/2) gravelly sandy clay loam, very dark brown (10YR 3/3) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; many very fine and few fine interstitial and tubular pores; few faint clay films bridging sand grains in Bt part; 5 percent cobbles, 20 percent pebbles; slightly acid (pH 6.4); clear smooth boundary. Can range from 0 to 8 inches thick.

Bt/E -- 14 to 19 inches; grayish brown (10YR 5/2) gravelly sandy clay loam, brown (10YR 4/3) moist; moderate medium and coarse prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and few fine and medium roots; many very fine and few fine interstitial and tubular pores; many faint clay films on faces of peds and bridging sand grains in Bt part; 5 percent cobbles, 20 percent pebbles; neutral (pH 6.6); clear wavy boundary. Can range from 6 to 10 inches thick.

Bt1 -- 19 to 30 inches; grayish brown (10YR 5/2) gravelly clay loam, brown (10YR 4/3) moist; moderate medium and coarse prismatic structure parting to strong fine and medium subangular blocky; hard, firm, sticky and slightly plastic; common very fine and few fine and medium roots; many very fine and few fine interstitial and tubular pores; many faint clay films on faces of peds and bridging sand grains; 5 percent cobbles and 25 percent pebbles; neutral (pH 6.7); clear wavy boundary.

WARNEKE SERIES

The Warneke series consists of shallow, well-drained soils that formed in residuum or colluvium weathered from limestone. These soils are on hills, mountains, and bedrock-floored plains. Slopes are 0 to 70 percent. Mean annual precipitation is about 18 inches. Mean annual air temperature is about 42° F.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic, frigid Lithic Ustochrepts

TYPICAL PEDON: Warneke gravelly loam, grassland (colors are for dry soil unless otherwise noted).

A -- 0 to 2 inches; brown (10YR 5/3) gravelly loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; common fine and medium roots; 20 percent pebbles, 5 percent cobbles; disseminated lime; strongly effervescent; neutral (pH 7.2); clear wavy boundary. Can range from 1 to 4 inches thick.

Bk -- 2 to 12 inches; very pale brown (10YR 7/3) very channery loam, pale brown (10YR 6/3) moist; moderate fine subangular blocky structure; hard, friable, sticky and slightly plastic; few fine and medium roots; common fine and very fine pores; 25 percent channers; 15 percent flagstone; disseminated lime; continuous distinct lime casts on underside of fragments; violently effervescent; neutral (pH 7.3); clear wavy boundary. Can range from 9 to 18 inches thick.

R -- 12+ inches; limestone, with few fractures.

DESCRIPTION LOCATION: Jefferson County, Montana; about 1,400 feet south and 1,450 feet west of the NE corner of Section 11, T. 5N, R. 3W.

FRANCONI (2) SERIES (Continued)

Bt2 -- 30 to 41 inches; grayish brown (10YR 5/2) gravelly clay loam, brown (10YR 4/3) moist; weak coarse prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine and few fine interstitial and tubular pores; common faint clay films on faces of peds and bridging sand grains; 5 percent cobbles, 20 percent pebbles; neutral (pH 6.6); clear smooth boundary. Combined thickness of Bt horizons can range from 13 to 25 inches.

Cr -- 41+ inches; grayish brown (2.5Y 5/2) decomposed diorite bedrock (grus) that crushes to very gravelly coarse sand; neutral (pH 6.9); gradual wavy boundary.

DESCRIPTION LOCATION: Jefferson County, Montana; 1,050 feet south and 1,700 feet west of the NE corner of Section 14, T. 6N, R. 3W.

VARNEY SERIES

The Varney series consists of very deep, well-drained soils that formed in alluvium. These soils are on alluvial fans, stream terraces, and hills. Slopes are 0 to 50 percent. Mean annual precipitation is about 13 inches, and mean annual air temperature is about 40°F.

TAXONOMIC CLASS: Fine-loamy, mixed Aridic Argiborolls

TYPICAL PEDON: Varney clay loam, cultivated, colors are for dry soil unless otherwise noted.

A -- 0 to 5 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine and very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine interstitial pores; 5 percent pebbles; neutral (pH 6.6); clear smooth boundary. (3 to 9 inches thick)

Bt -- 5 to 16 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium and fine subangular blocky structure; hard, sticky and plastic; many fine and very fine roots; common fine tubular pores; continuous, faint clay films on faces of peds; 10 percent pebbles; neutral (pH 7.3); clear irregular boundary. (5 to 15 inches thick)

Bk1 -- 16 to 28 inches; light gray (10YR 7/2) gravelly sandy clay loam, pale brown (10YR 6/3) moist; weak coarse prismatic structure; slightly hard, friable, slightly sticky and nonplastic; common fine and very fine roots; common fine and very fine pores; 15 percent pebbles and 5 percent cobbles; common fine masses of lime; violently effervescent; moderately alkaline (pH 7.9); gradual smooth boundary. (5 to 25 inches thick)

Bk2 -- 28 to 48 inches; very pale brown (10YR 7/3) gravelly sandy loam, pale brown (10YR 6/3) moist; weak, coarse, prismatic structure; soft, friable, slightly sticky and nonplastic; few fine roots; few fine pores; 15 percent pebbles and 5 percent cobbles; disseminated lime; few fine masses of lime; strongly effervescent; moderately alkaline (pH 7.9); clear smooth boundary. (5 to 25 inches thick)

BC -- 48 to 60 inches; light brown (7.5YR 6/4) stratified gravelly sandy loam and gravelly loamy sand, brown (7.5YR 5/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few fine roots; few fine pores; 20 percent pebbles and 5 percent cobbles; slightly effervescent; moderately alkaline (pH 8.4).

TYPE LOCATION: Madison County, Montana; 2,400 feet north and 2,300 feet west of the SE corner of Section 32, T. 2S., R. 1W.

HANSON SERIES

The Hanson series consists of very deep, well-drained soils that formed in colluvium, alluvium, and glacial till derived from limestone rock. These soils are on stream terraces, alluvial fans, mountains, hills, and moraines. Slopes are 0 to 70 percent. Mean annual precipitation is about 23 inches. Mean annual temperature is about 40° F.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic Calcic Cryoborolls

TYPICAL PEDON: Hanson loam, native grass (colors are for dry soil unless otherwise noted).

A1 -- 0 to 8 inches; very dark grayish brown (10YR 3/2) loam, black (10YR 2/1) moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; 5 percent pebbles; slightly acid (pH 6.5); gradual smooth boundary. Can range from 8 to 12 inches thick.

A2 -- 8 to 14 inches; dark grayish brown (10YR 4/2) loam, black (10YR 2/1) moist; weak medium prismatic structure parting to weak medium and fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular and interstitial pores; 10 percent limestone pebbles; disseminated lime; strongly effervescent; neutral (pH 7.0); clear smooth boundary. Can range from 0 to 6 inches thick.

Bk1 -- 14 to 21 inches; grayish brown (10YR 5/2) very cobbly loam, dark grayish brown (10YR 4/2) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular and interstitial pores; 50 percent cobbles, 10 percent pebbles; disseminated lime; many masses of lime; continuous distinct lime crusts on underside of fragments; violently effervescent; mildly alkaline (pH 7.5); diffuse smooth boundary. Can range from 10 to 20 inches thick.

Bk2 -- 21 to 43 inches; light brownish gray (10YR 6/2) extremely cobbly loam, light brownish gray (10YR 6/2) moist; moderate fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; many very fine tubular and interstitial pores; 55 percent cobbles, 25 percent pebbles; disseminated lime; many masses of lime; continuous distinct lime crusts on undersides of fragments; violently effervescent; mildly alkaline (pH 7.8); gradual wavy boundary. Can range from 10 to 20 inches thick.

Bk3 -- 43+ inches; pale yellow (2.5Y 7/4) extremely cobbly loam, light yellowish brown (2.5Y 6/4) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular and interstitial pores; 55 percent cobbles, 10 percent pebbles; disseminated lime; continuous distinct lime coatings on fragments; violently effervescent.

DESCRIPTION LOCATION: Jefferson County, Montana; 1,700 feet west and 300 feet south of the NE corner of Section 14, T. 6N, R. 3W.

TROPAL (2) SERIES

The Tropol (2) series consists of shallow, somewhat excessively drained soils that formed in residuum and colluvium derived from limestone. These soils are on hills and mountains. Slopes are 8 to 65 percent. Mean annual precipitation is about 17 inches, and mean annual air temperature is about 38°F.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic Lithic Cryochrepts

TYPICAL PEDON: Tropol very gravelly loam, bouldery, forested, colors are for dry soil unless otherwise noted.

Oi -- 1 to 0 inches; partially decomposed needles, twigs and leaves.

A -- 0 to 7 inches; dark grayish brown (10YR 4/2) very gravelly loam, very dark gray (10YR 3/1) moist; moderate medium granular structure; slightly hard, very friable, nonsticky and nonplastic; many fine roots; common very fine and fine pores; 30 percent pebbles, 5 percent cobbles; continuous distinct lime coatings on underside of fragments; violently effervescent; mildly alkaline (pH 7.4); abrupt smooth boundary. Can range from 2 to 6 inches thick.

Bk -- 7 to 15 inches; grayish brown (10YR 5/2) very gravelly loam, very dark gray (10YR 3/1) moist; fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; common very fine and fine pores; 40 percent pebbles, 10 percent cobbles; continuous prominent lime casts on fragments; disseminated lime; violently effervescent; mildly alkaline (pH 7.4); gradual wavy boundary. Can range from 7 to 13 inches thick.

R -- 15+ inches; light gray (10YR 7/1) hard limestone.

DESCRIPTION LOCATION: Jefferson County, Montana; 1,500 feet east and 350 feet north of the SW corner of Section 11, T. 6N, R. 3W.

HELMVILLE SERIES

The Helmville series consists of very deep, well-drained soils that formed in colluvium and alluvium derived from limestone, argillite, and igneous rock. These soils are on mountains. Slopes are 4 to 60 percent. Mean annual precipitation is about 25 inches. Mean annual temperature is about 37° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Typic Cryoboralfs

TYPICAL PEDON: Helmville cobbly loam, forested (colors are for dry soil unless otherwise noted).

Oi -- 1 inch to 0; forest litter, slightly decomposed.

E -- 0 to 10 inches; light brownish gray (10YR 6/2) cobbly loam, brown (10YR 4/3) moist; weak fine granular structure; soft, friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many very fine and fine discontinuous irregular pores; 15 percent cobbles and 15 percent pebbles; slightly acid (pH 6.5); gradual wavy boundary. Can range from 5 to 15 inches thick.

Bt1 -- 10 to 18 inches; yellowish brown (10YR 5/4) very cobbly clay loam, brown (10YR 4/3) moist; weak medium subangular blocky structure parting to weak medium granular; slightly hard, friable, slightly sticky and plastic; many very fine and fine, common medium, and few coarse roots; many very fine and fine discontinuous irregular pores; many thin continuous clay films on faces of peds; 25 percent cobbles and 20 percent pebbles; slightly acid (pH 6.4); gradual wavy boundary. Can range from 0 to 8 inches thick.

Bt2 -- 18 to 38 inches; yellowish brown (10YR 5/4) very cobbly clay loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine, fine and medium roots; many very fine and fine discontinuous irregular pores; many thin continuous clay films on faces of peds; 30 percent cobbles and 25 percent pebbles; neutral (pH 6.7); clear smooth boundary. Can range from 9 to 20 inches thick.

Bk -- 38 to 60 inches; light yellowish brown (10YR 6/4) very cobbly clay loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; many very fine and fine discontinuous irregular pores; 30 percent pebbles and 30 percent cobbles; disseminated lime; continuous distinct lime coating on pebbles and cobbles, faint distinct lime casts on undersides of the rock fragments; violently effervescent; mildly alkaline (pH 7.5).

DESCRIPTION LOCATION: Jefferson County, Montana; 1,250 feet west and 2,100 feet north of the SE corner of Section 10, T. 6N, R. 3W.

TROPAL SERIES

The Tropal series consists of shallow, somewhat excessively drained soils that formed in residuum and colluvium derived from limestone. These soils are on hills and mountains. Slopes are 8 to 65 percent. Mean annual precipitation is about 17 inches, and mean annual air temperature is about 38°F.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic Lithic Cryochrepts

TYPICAL PEDON: Tropal very gravelly loam, bouldery, forested, colors are for dry soil unless otherwise noted.

Oi -- 1/2 to 0 inches; partially decomposed needles, twigs and leaves.

A -- 0 to 4 inches; very dark gray (10YR 3/1) very gravelly loam, black (10YR 2/1) moist; moderate medium granular structure; slightly hard, very friable, nonsticky and nonplastic; many fine roots; common very fine and fine pores; 40 percent pebbles, 5 percent cobbles; continuous distinct lime coatings on underside of fragments; violently effervescent; mildly alkaline (pH 7.5); abrupt smooth boundary. Can range from 2 to 6 inches thick.

Bk -- 4 to 15 inches; dark grayish brown (10YR 4/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; common very fine and fine pores; 50 percent pebbles, 10 percent cobbles; continuous prominent lime casts on fragments; disseminated lime; violently effervescent; mildly alkaline (pH 7.5); gradual wavy boundary. Can range from 7 to 13 inches thick.

R -- 15+ inches; light gray (10YR 7/1) hard limestone.

DESCRIPTION LOCATION: Jefferson County, Montana; 1,600 feet south and 600 feet west of the NW corner of Section 11, T. 6N, R. 3W.

HILGER SERIES

The Hilger series consists of very deep, well-drained soils that formed in alluvium, colluvium or till from igneous rock and sandstone. These soils are on alluvial fans, stream terraces, mountains, and moraines. Slopes are 0 to 60 percent. Mean annual precipitation is about 17 inches. Mean annual temperature is about 41° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Typic Argiborolls

TYPICAL PEDON: Hilger very stony loam, rangeland (colors are for dry soil unless otherwise noted).

A -- 0 to 5 inches; very dark grayish brown (10YR 3/2) very stony loam, very dark brown (10YR 2/2) moist; moderate fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many fine and very fine roots; 10 percent stones, 15 percent cobbles, 15 percent pebbles; moderately acid (pH 5.9); clear wavy boundary. Can range from 4 to 6 inches thick.

Bt1 -- 5 to 9 inches; brown (10YR 4/3) very cobbly clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to strong fine subangular blocky; hard, firm, sticky and plastic; many very fine roots and pores; 5 percent stones, 25 percent cobbles, 15 percent pebbles; many faint clay film on faces of peds and on surface of rock fragments; slightly acid (pH 6.1); clear wavy boundary. Can range from 3 to 8 inches thick.

Bt2 -- 9 to 15 inches; brown (10YR 5/3) extremely cobbly clay loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to strong very fine subangular blocky; hard, firm, sticky and plastic; many very fine roots and pores; continuous faint clay films faces of peds and on surface of coarse fragments; 5 percent stones, 35 percent cobbles, 25 percent pebbles; neutral (pH 7.0); clear wavy boundary. Can range from 6 to 10 inches thick.

Bk1 -- 15 to 19 inches; light brownish gray (2.5Y 6/2) extremely cobbly loam, grayish brown (2.5Y 5/2) moist; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots and pores; 5 percent stones, 30 percent cobbles, 25 percent pebbles; few large masses of lime; continuous distinct lime casts on underside of rock fragments; strongly effervescent; mildly alkaline (pH 7.6); gradual wavy boundary.

Bk2 -- 19 to 24 inches; light gray (2.5Y 7/2) extremely cobbly loam, grayish brown (2.5Y 5/2) moist; moderate very fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; 5 percent stones, 45 percent cobbles, 10 percent pebbles; common fine masses and filaments of lime; continuous distinct lime casts on surface of rock fragments; strongly effervescent; moderately alkaline (pH 7.7); gradual wavy boundary. Can range from 6 to 10 inches thick.

TOLBERT SERIES

The Tolbert series consists of shallow, well-drained soils that formed in colluvium or residuum derived from hard fine grained sandstone or fine grained igneous rocks. These soils are on hills and mountains. Slopes are 8 to 60 percent. Mean annual precipitation is about 16 inches. Mean annual temperature is about 40° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Lithic Argiborolls

TYPICAL PEDON: Tolbert very cobbly loam, bouldery, in rangeland (colors are for dry soil unless otherwise noted).

A -- 0 to 5 inches; dark grayish brown (10YR 4/2) very cobbly loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine interstitial pores; 30 percent cobbles, 10 percent pebbles; neutral (pH 7.1); clear wavy boundary. Can range from 5 to 8 inches thick.

Bt -- 5 to 9 inches; brown (10YR 5/3) very cobbly clay loam, brown (10YR 4/3) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine and fine roots; many very fine and fine interstitial and tubular pores; common distinct dark grayish brown (10YR 4/2) clay films on faces of peds and bridging sand grains; 40 percent cobbles, 15 percent pebbles; mildly alkaline (pH 7.6). Can range from 5 to 15 inches thick.

BC -- 9 to 11 inches; light yellowish brown (10YR 6/4) very cobbly loam, darkish yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots, 45 percent cobbles, 20 percent pebbles; mildly alkaline (pH 7.5).

R -- 12+ inches; hard fine grained igneous rock.

DESCRIPTION LOCATION: Jefferson County, Montana; 600 feet north and 1,700 feet west of the SE corner of Section 9, T. 5N, R. 3W.

HILGER SERIES (Continued)

BC -- 24 to 60 inches; light yellowish brown (2.5Y 6/4) extremely stony loam, olive brown (2.5Y 4/4) moist; massive; hard, very friable, nonsticky and nonplastic; 20 percent stones, 30 percent cobbles, 20 percent pebbles; disseminated lime; strongly effervescent; mildly alkaline (pH 7.5).

DESCRIPTION LOCATION: Jefferson County, Montana; about 2,400 feet south and 1,400 feet east of the NW corner of Section 10, T. 5N, R. 3W.

TIGERON (2) SERIES (Continued)

Bt -- 22 to 60 inches; brown (7.5YR 4/4) extremely flaggy sandy clay loam, dark yellowish brown (10YR 3/6) moist; strong fine and medium blocky structure; extremely hard, friable, sticky and plastic; few fine and very fine roots; many fine and very fine pores and few medium pores; continuous prominent clay films on all faces of peds and in root channels; continuous prominent clay films on all surfaces of smaller fragments and on undersides of larger fragments; common faint coating of sand grains on faces of peds and on surface of fragments; 30 percent flagstones, 30 percent channers; moderately acid (pH 6.0); gradual wavy boundary. Can range from 16 to 41 inches thick.

2C -- 60+ inches; yellowish brown (10YR 5/6) very flaggy loam, dark yellowish brown (10YR 4/6) moist; massive; extremely hard, friable, sticky and plastic; few fine and very fine roots; common fine and very fine pores; 30 percent flagstones, 20 percent channers; neutral (pH 6.9).

DESCRIPTION LOCATION: Jefferson County, Montana; 50 feet south and 550 feet east of the NW corner of Section 14, T. 6N, R. 3W.

JUELLE SERIES

The Judell series consists of deep, well-drained soils that formed in calcareous alluvium derived mainly from limestone. These soils are on terraces and fans. Slopes are 0 to 8 percent. Mean annual precipitation is about 16 inches. Mean annual temperature is about 42° F.

TAXONOMIC CLASS: Fine-loamy, carbonatic Typic Calciborolls

TYPICAL PEDON: Judell clay loam, grassland (colors are for dry soil unless otherwise noted).

A -- 0 to 7 inches; dark grayish brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; moderate fine granular structure; slightly hard, very friable, sticky and plastic; many fine and very fine roots and common medium and coarse roots; less than 5 percent limestone pebbles; slightly effervescent; mildly alkaline (pH 7.6); clear smooth boundary. (6 to 10 inches thick)

B2ca -- 7 to 11 inches; pale brown (10YR 6/3) clay loam, dark brown (10YR 4/3) moist; moderate fine subangular blocky structure; hard, friable, sticky and plastic; many fine and very fine roots and common medium and coarse roots; many fine and very fine pores; less than 5 percent limestone pebbles; few fine irregular soft masses of lime; violently effervescent; moderately alkaline (pH 8.2); clear wavy boundary. (4 to 10 inches thick)

B3ca -- 11 to 28 inches; very pale brown (10YR 7/3) clay loam, dark brown (10YR 4/3) moist; moderate fine subangular blocky structure; very hard, friable, sticky and plastic; common fine and very fine roots and few medium and coarse roots; many fine and very fine pores and few medium pores; less than 5 percent lime coated pebbles; common fine and medium irregular soft masses of lime; violently effervescent; moderately alkaline (pH 8.4); gradual wavy boundary. (10 to 16 inches thick)

C1ca -- 28 to 54 inches; very pale brown (10YR 7/3) clay loam, brown (10YR 5/3) moist; common fine and medium subangular blocky structure; hard, friable, sticky and plastic; few fine and very fine roots and few medium roots; many fine and very fine pores; less than 5 percent limestone pebbles; disseminated lime; violently effervescent; moderately alkaline (pH 8.4); gradual wavy boundary. (20 to 36 inches thick)

IIC2 -- 54 to 67 inches; pale brown (10YR 6/3) extremely gravelly loam, dark brown (10YR 4/3) moist; massive; soft, friable, sticky and plastic; few fine and very fine roots; common very fine and fine pores; 60 percent pebbles, 5 percent cobbles; violently effervescent; moderately alkaline (pH 8.4).

TYPE LOCATION: Fergus County, Montana; 1,815 feet west and 660 feet south of the NE corner of Section 10, T. 15N, R. 18E.

TIGERON (2) SERIES

The Tigeron (2) series consists of very deep, well-drained soils that formed in colluvium or alluvium derived from sandstone, argillite, quartzite, and other igneous rock. These soils are on alluvial fans, hills, and mountains. Slopes are 2 to 60 percent. Mean annual precipitation is about 24 inches. Mean annual temperature is about 41° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Typic Cryoboralfs

TYPICAL PEDON: Tigeron (2) flaggy sandy loam, forested (colors are for dry soil unless otherwise noted).

O -- 1 inch to 0; forest litter of undecomposed and decomposed needles, twigs, and cones.

E1 -- 0 to 2 inches; dark grayish brown (10YR 4/2) flaggy sandy loam, very dark grayish brown (10YR 2/2) moist; strong thin platy structure; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; continuous coatings of sand grains on surface of plates; 10 percent flagstones, 5 percent channers; slightly acid (pH 6.1); clear wavy boundary.

E2 -- 2 to 8 inches; grayish brown (10YR 5/2) flaggy sandy loam, brown (10YR 4/3) moist; moderate thin platy structure; slightly hard, very friable, nonsticky and nonplastic; many fine and very fine roots; continuous coatings of sand grains on plates; 20 percent flagstones, 10 percent channers; moderately acid (pH 5.8); clear wavy boundary. E horizons can range from 7 to 18 inches thick.

E and Bt -- 8 to 13 inches; brown (10YR 5/3) flaggy sandy loam, brown (10YR 4/3) moist; 1/16 to 3/8 inch thick lamellae; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine pores and few medium pores; thin clay films in root channels; 20 percent flagstones, 10 percent channers; moderately acid (pH 5.7); clear wavy boundary. Can range from 6 to 17 inches thick.

Bt and E -- 13 to 24 inches; dark yellowish brown (10YR 4/4) very flaggy sandy clay loam, dark brown (10YR 4/3) moist; 1/16- to 1/2-inch thick lamellae; strong fine and fine blocky structure; very hard, friable, sticky and plastic; common fine and very fine roots; many fine and very fine pores and few medium pores; continuous faint clay films on faces of peds and on undersides of fragments and in root channels; 30 percent flagstones, 15 percent channers; moderately acid (pH 5.8); gradual wavy boundary. Can range from 0 to 20 inches thick.

LAP SERIES

The Lap series consists of shallow, well-drained soils that formed in residuum and colluvium from limestone. These soils are on bedrock-floored plains and mountains. Slopes are 0 to 75 percent. Mean annual precipitation is about 17 inches. Mean annual temperature is about 43° F.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic Lithic Calciborolls

TYPICAL PEDON: Lap channery loam, grassland (colors are for dry soil unless otherwise noted).

A -- 0 to 5 inches; dark grayish brown (10YR 4/2) channery loam, very dark grayish brown (10YR 3/2) moist; weak very fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; 35 percent channers (flat 1 to 4 inch diameter limestone fragments); neutral (pH 6.8); clear wavy boundary. Can range from 4 to 9 inches thick.

Bk1 -- 5 to 9 inches; light brownish gray (10YR 6/2) very channery loam, dark grayish brown (10YR 4/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; 50 percent channers; disseminated lime, continuous prominent lime casts on underside of channers; strongly effervescent; mildly alkaline (pH 7.5); clear wavy boundary. Can range from 2 to 6 inches thick.

Bk2 -- 9 to 19 inches; light gray (10YR 7/2) extremely channery loam, brown (10YR 5/3) moist; massive; slightly hard, friable, sticky and plastic; few very fine roots; 65 percent channers; disseminated lime, continuous prominent lime casts on underside of channers; violently effervescent; mildly alkaline (pH 7.8); gradual irregular boundary. Can range from 4 to 8 inches thick.

R -- 19 inches; hard limestone bedrock with some cracks.

DESCRIPTION LOCATION: Jefferson County, Montana; 250 feet west and 1,900 feet north of the SE corner of Section 10, T. 5N; R. 3W.

TIGERON SERIES (Continued)

Bt -- 20 to 42 inches; pale brown (10YR 6/3) extremely flaggy sandy clay loam, brown (10YR 4/3) moist; strong fine and medium blocky structure; extremely hard, friable, sticky and plastic; few fine and very fine roots; many fine and very fine pores and few medium pores; continuous prominent clay films on all faces of peds and in root channels; continuous prominent clay films on all surfaces of smaller fragments and on undersides of larger fragments; common faint coating of sand grains on faces of peds and on surface of fragments; 30 percent flagstones, 30 percent channers; slightly acid (pH 6.1); gradual wavy boundary. Can range from 16 to 41 inches thick.

2C -- 42 to 60 inches; gray (10YR 6/1) very flaggy loam, dark gray (10YR 4/1) moist; massive; extremely hard, friable, sticky and plastic; few fine and very fine roots; common fine and very fine pores; 30 percent flagstones, 20 percent channers; neutral (pH 7.1).

DESCRIPTION LOCATION: Jefferson County, Montana; 2,100 feet east and 2,200 feet south of the NW corner of Section 4, T. 5N, R. 3W.

LIBEG SERIES

The Libeg series consists of very deep, well-drained soils that formed in till, colluvium, and alluvium. These soils are on mountains, alluvial fans, stream terraces, alpine moraines, hills, and avalanche chutes. Slopes are 0 to 70 percent. Mean annual precipitation is about 22 inches. Mean annual temperature is about 40° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Argic Cryoborolls

TYPICAL PEDON: Libeg stony loam, grassland (colors are for dry soil unless otherwise noted).

A -- 0 to 6 inches; dark grayish brown (10YR 4/2) extremely stony loam, very dark brown (10YR 2/2) moist; weak thin platy structure parting to moderate fine and very fine granular; slightly hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots, few medium roots; many fine and very fine pores; 15 percent rock fragments; neutral (pH 6.7); clear wavy boundary. Can range from 4 to 11 inches thick.

Bt1 -- 6 to 12 inches; yellowish brown (10YR 5/4) very channery heavy loam, dark brown (10YR 3/3) moist; strong very fine subangular blocky structure; hard, friable, sticky and plastic; many fine and very fine roots; many fine and very fine pores; continuous faint clay film on faces of some peds and on rock fragments; 25 percent channery fragments; neutral (pH 6.7); clear wavy boundary.

Bt2 -- 12 to 20 inches; yellowish brown (10YR 5/4) very channery light clay loam, dark brown (10YR 3/4) moist; strong fine and very fine angular blocky structure; very hard, friable, sticky and plastic; many fine and very fine roots; many fine and very fine pores; continuous faint clay film on faces of some peds and on rock fragments; 30 percent rock fragments; neutral (pH 6.9); clear wavy boundary.

Bt3 -- 20 to 32 inches; yellowish brown (10YR 5/4) very channery sandy clay loam, brown (10YR 4/3) moist; strong fine and medium angular blocky structure; extremely hard, friable, sticky and plastic; common fine and very fine roots, few coarse roots; many fine and very fine pores, few medium pores; thin continuous clay films on all faces of peds and on rock fragments; 45 percent rock fragments; mildly alkaline (pH 7.4); gradual irregular boundary. Bt horizons can range from 24 to 40 inches thick.

BC -- 32 to 60 inches; yellowish brown (10YR 5/4) very stony sandy loam, brown (10YR 4/5) moist; weak medium and fine subangular blocky structure; very hard, friable, sticky and plastic; few fine and very fine roots; common fine and very fine pores; 45 percent rock fragments; moderately alkaline (pH 7.9).

DESCRIPTION LOCATION: Jefferson County, Montana; 1,600 feet west and 1,900 feet south of the NE corner of Section 22, T. 6N, R. 3W.

TIGERON SERIES

The Tigon series consists of very deep, well-drained soils that formed in colluvium or alluvium derived from sandstone, argillite, quartzite, and other igneous rock. These soils are on alluvial fans, hills, and mountains. Slopes are 2 to 60 percent. Mean annual precipitation is about 24 inches. Mean annual temperature is about 41° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Typic Cryoboralfs

TYPICAL PEDON: Tigon flaggy sandy loam, forested (colors are for dry soil unless otherwise noted).

O -- 1 inch to 0; forest litter of undecomposed and decomposed needles, twigs, and cones.

E1 -- 0 to 4 inches; light brownish gray (10YR 6/2) flaggy sandy loam, very dark grayish brown (10YR 3/2) moist; strong thin platy structure; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; continuous coatings of sand grains on surface of plates; 10 percent flagstones, 5 percent channers; moderately acid (pH 5.8); clear wavy boundary.

E2 -- 4 to 10 inches; light gray (10YR 7/2) flaggy sandy loam, dark grayish brown (10YR 4/2) moist; moderate thin platy structure; slightly hard, very friable, nonsticky and nonplastic; many fine and very fine roots; continuous coatings of sand grains on plates; 20 percent flagstones, 10 percent channers; slightly acid (pH 6.4); clear wavy boundary. E horizons can range from 7 to 18 inches thick.

E and Bt -- 10 to 16 inches; E part (75 percent) light gray (10YR 7/2) flaggy sandy loam, grayish brown (10YR 5/2) moist; Bt part (25 percent) pale brown (10YR 6/3) sandy clay loam, dark brown (10YR 4/3) moist; 1/16 to 3/8 inch thick lamellae; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine pores and few medium pores in the E and lamellae; thin clay films in root channels; 20 percent flagstones, 10 percent channers; slightly acid (pH 6.5); clear wavy boundary. Can range from 6 to 17 inches thick.

Bt and E -- 16 to 20 inches; Bt part (60 percent) pale brown (10YR 6/3) very flaggy sandy clay loam, dark brown (10YR 4/3) moist; 1/16- to 1/2-inch thick lamellae; E part (40 percent) light gray (10YR 7/2) sandy loam, dark grayish brown (10YR 4/2) moist; strong fine and fine blocky structure; very hard, friable, sticky and plastic; common fine and very fine roots; many fine and very fine pores and few medium pores; continuous faint clay films on faces of peds and on undersides of fragments and in root channels; 30 percent flagstones, 15 percent channers; slightly acid (pH 6.3); gradual wavy boundary. Can range from 0 to 20 inches thick.

MAIDEN SERIES

The Maiden series consists of moderately deep, well-drained soils that formed in colluvium and residuum derived from limestone. These soils are on sedimentary uplands and mountains. Slopes are 2 to 60 percent. Mean annual precipitation is about 16 inches. Mean annual air temperature is about 40° F.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic Typic Calciborolls

TYPICAL PEDON: Dryhollow very gravelly loam, in rangeland (colors are for dry soil unless otherwise noted).

A1 -- 0 to 4 inches; dark grayish brown (10YR 4/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium granular structure; slightly hard, very friable, nonsticky and nonplastic; many fine and very fine roots; many very fine and fine interstitial pores; 5 percent cobbles and 35 percent pebbles; disseminated lime; few faint coatings of lime on undersides of fragments; strongly effervescent; neutral (pH 7.3); abrupt wavy boundary.

A2 -- 4 to 7 inches; grayish brown (10YR 5/2) very gravelly loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial and tubular pores; 15 percent cobbles and 40 percent pebbles; disseminated lime with common fine masses of light gray (10YR 7/2) lime; few faint lime coatings on fragments; violently effervescent; neutral (pH 7.2); clear wavy boundary. Combined thickness of A horizons can range from 5 to 8 inches.

Bk1 -- 7 to 11 inches; light gray (10YR 7/2) very gravelly loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; many fine and very fine roots; common fine and many very fine interstitial and tubular pores; 25 percent cobbles and 30 percent pebbles; disseminated lime with many medium masses and threads of white (10YR 8/2) lime; common distinct lime casts around fragments; violently effervescent; mildly alkaline (pH 7.4); gradual wavy boundary.

Bk2 -- 11 to 26 inches; light brownish gray (10YR 6/2) very cobbly loam, grayish brown (10YR 5/2) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; few very fine roots; few to common very fine interstitial and tubular pores; 20 percent cobbles and 40 percent pebbles; disseminated lime with many medium masses and threads of white (10YR 8/2) lime; many prominent lime casts around fragments; violently effervescent; mildly alkaline (pH 7.7); abrupt smooth boundary. Combined thickness of Bk horizons can range from 15 to 25 inches.

R -- 26+ inches; light gray (10YR 7/2) hard limestone.

DESCRIPTION LOCATION: Jefferson County, Montana; 1,900 feet north and 1,250 feet west of the SE corner of Section 11, T. 5N, R. 3W.

TEPECREEK (2) SERIES

The Tepecreek (2) series consists of moderately deep, well-drained soils that formed in colluvium or residuum derived from granite bedrock. These soils are on dissected bedrock floored plains, hills and mountains. Slopes are 25 to 60 percent. Mean annual precipitation is about 22 inches. Mean annual temperature is about 38° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Typic Cryoboralfs

TYPICAL PEDON: Tepecreek gravelly sandy clay loam, very bouldery, forested (colors are for dry soil unless otherwise noted).

Oi -- 1 to 0 inches; partially decomposed needles, twigs and leaves. Can range from 1/2 to 3 inches thick.

A -- 0 to 2 inches; brown (7.5YR 5/2) gravelly sandy clay loam, dark brown (10YR 3/3) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine and fine and few medium pores; 25 percent pebbles; strongly acid (pH 5.4); clear smooth boundary. Can range from 2 to 4 inches thick.

E -- 2 to 7 inches; brown (7.5YR 5/2) very gravelly sandy clay loam, dark brown (10YR 3/3) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine and fine and few medium pores; 40 percent pebbles; strongly acid (pH 5.4); clear smooth boundary. Can range from 3 to 8 inches thick.

Bt -- 7 to 22 inches; pale brown (10YR 6/3) very gravelly sandy clay loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; many very fine and few fine and medium roots; many very fine and few interstitial and tubular pores; many faint clay films bridging sand grains; 40 percent pebbles; slightly acid (pH 6.2); clear wavy boundary. Can range from 5 to 15 inches thick.

BC -- 22 to 32 inches; yellowish brown (10YR 5/4) very gravelly sandy loam, brown (10YR 4/3) moist; weak very fine and fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; many very fine and few fine roots; many very fine and few fine interstitial and tubular pores; 55 percent pebbles; slightly acid (pH 6.2); clear wavy boundary. Can range from 11 to 28 inches thick.

Cr -- 32 to 52 inches; brown (10YR 4/3) decomposed quartz monzonite bedrock (grus) that crushes to very gravelly loamy coarse sand; slightly acid (pH 6.4); gradual wavy boundary.

R -- 52+ inches; hard quartz monzonite bedrock.

DESCRIPTION LOCATION: Jefferson County, Montana; 1,350 feet north and 2,250 feet west of the SE corner of Section 10, T. 6N, R. 3W.

MARTINSDALE SERIES

The Martinsdale series consists of very deep, well-drained soils that formed in alluvium. These soils are on alluvial fans, stream terraces, and hills mantled with old alluvium. Slopes are 0 to 35 percent. Mean annual precipitation is about 16 inches. Mean annual temperature is about 41° F.

TAXONOMIC CLASS: Fine-loamy, mixed Typic Argiborolls

TYPICAL PEDON: Martinsdale gravelly loam, cultivated (colors are for dry soil unless otherwise noted).

A -- 0 to 3 inches; dark brown (10YR 4/3) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; strong fine granular structure; hard, friable, sticky and plastic; 15 percent fine pebbles; slightly acid (pH 6.4); clear wavy boundary. Can range from 3 to 7 inches thick.

Bt1 -- 3 to 6 inches; dark yellowish brown (10YR 4/4) sandy clay loam, dark brown (10YR 3/3) moist; strong fine and medium prismatic structure parting to moderate medium blocky; hard, friable, sticky and plastic; many distinct dark brown (10YR 3/3) clay films on faces of peds; neutral (pH 6.7); clear smooth boundary. Can range from 3 to 8 inches thick.

Bt2 -- 6 to 10 inches; yellowish brown (10YR 5/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; strong fine and medium prismatic structure parting to weak fine granular; hard, friable, sticky and plastic; common fine and very fine roots with some concentration between prisms; many distinct dark brown (10YR 3/3) clay films on faces of peds; neutral (pH 6.8); clear wavy boundary. Can range from 5 to 10 inches thick.

Btk -- 10 to 12 inches; yellowish brown (10YR 5/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; common roots; few faint clay films on faces of peds; slightly effervescent; few fine masses of lime; mildly alkaline (pH 7.5); abrupt broken boundary. Can range from 0 to 7 inches thick.

Bk1 -- 12 to 34 inches; white (10YR 8/2) sandy clay loam, light gray (10YR 7/2) moist; weak medium platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common roots in upper part, few in lower part; lime disseminated throughout as coarse common masses and as bands; violently effervescent; moderately alkaline (pH 8.0); gradual wavy boundary. Can range from 7 to 20 inches thick.

TEPECREEK SERIES

The Tepecreek series consists of moderately deep, well-drained soils that formed in colluvium or residuum derived from granite bedrock. These soils are on dissected bedrock floored plains, hills and mountains. Slopes are 25 to 60 percent. Mean annual precipitation is about 22 inches. Mean annual temperature is about 38° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Typic Cryoboralfs

TYPICAL PEDON: Tepecreek gravelly sandy clay loam, very bouldery, forested (colors are for dry soil unless otherwise noted).

Oi -- 1 to 0 inches; partially decomposed needles, twigs and leaves. Can range from 1/2 to 3 inches thick.

A -- 0 to 4 inches; dark grayish brown (10YR 4/2) gravelly sandy clay loam, very dark brown (10YR 2/2) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine and fine and few medium pores; 25 percent pebbles; slightly acid (pH 6.1); clear smooth boundary. Can range from 2 to 4 inches thick.

E -- 4 to 14 inches; grayish brown (10YR 5/2) very gravelly sandy clay loam, dark grayish brown (10YR 4/2) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine and fine and few medium pores; 40 percent pebbles; neutral (pH 6.6); clear smooth boundary. Can range from 3 to 8 inches thick.

Bt -- 14 to 28 inches; grayish brown (10YR 5/2) very gravelly sandy clay loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; many very fine and few fine and medium roots; many very fine and few interstitial and tubular pores; many faint clay films bridging sand grains; 40 percent pebbles; neutral (pH 7.2); clear wavy boundary. Can range from 5 to 15 inches thick.

BC -- 28 to 36 inches; grayish brown (10YR 5/2) very gravelly sandy loam, dark grayish brown (10YR 4/2) moist; weak very fine and fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; many very fine and few fine roots; many very fine and few fine interstitial and tubular pores; 55 percent pebbles; mildly alkaline (pH 7.4); clear wavy boundary. Can range from 11 to 28 inches thick.

Cr -- 36 to 53 inches; grayish olive brown (10YR 5/2) decomposed quartz monzonite bedrock (grus) that crushes to very gravelly loamy coarse sand; mildly alkaline (pH 7.7); gradual wavy boundary.

R -- 53+ inches; hard quartz monzonite bedrock.

DESCRIPTION LOCATION: Jefferson County, Montana; 900 feet south and 300 feet east of the NW corner of Section 11, T. 6N, R. 3W.

MARTINSDALE SERIES (Continued)

Bk2 -- 34 to 50 inches; pale brown (10YR 6/3) sandy clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; lime segregated in few fine threads and coarse masses; violently effervescent; strongly alkaline (pH 8.6); clear wavy boundary. Can range from 15 to 30 inches thick.

BC -- 50+ inches; light yellowish brown (2.5Y 6/4) gravelly sandy loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, very friable; nonsticky and nonplastic; strongly effervescent; moderately alkaline (pH 8.0). Can range from 0 to 15 inches thick.

DESCRIPTION LOCATION: Jefferson County, Montana; about 2,450 feet south and 200 feet west of the NE corner of Section 4, T. 5N, R. 3W.

SLOCUM SERIES

The Slocum series consists of deep, somewhat poorly drained soils that formed in loamy alluvium. These soils are on low terraces of rivers and streams. Slopes are 0 to 4 percent. Mean annual precipitation is about 23 inches. Mean annual temperature is about 42° F.

TAXONOMIC CLASS: Fine, loamy, mixed Aquic Cryoborolls

TYPICAL PEDON: Slocum loam, rangeland (colors are for dry soil unless otherwise noted).

A -- 0 to 14 inches; dark gray (10YR 4/1) fine loam, black (10YR 2/1) moist; moderate medium crumb structure; soft, friable, sticky and plastic; many very fine roots and interstitial pores; (pH 6.9); clear wavy boundary. (10 to 15 inches thick)

Bw -- 14 to 24 inches; light brownish gray (10YR 6/2) clay loam, very dark grayish brown (10YR 3/2) moist; common fine brown stains around root channels; weak medium and coarse blocky structure; hard, firm, sticky and plastic; many very fine roots; many very fine pores; (pH 7.6); clear wavy boundary. (5 to 15 inches thick)

Bg -- 24 to 33 inches; light brownish gray (10YR 6/2) silty clay loam, very dark gray (10YR 3/1) moist; many fine brown mottles, moist; weak medium and coarse blocky structure; hard, friable, slightly sticky and slightly plastic; common fine roots; many fine and very fine pores; (pH 8.2); clear boundary.

Cg -- 33 to 60 inches; gray (10YR 5/1) clay loam, very dark gray (10YR 3/1) moist; massive; hard, friable, sticky and plastic; water table at 33 inches; (pH 8.2); clear wavy boundary.

2Cg -- 60 to 65 inches; gray (10YR 5/1) very fine sandy loam, very dark gray (10YR 3/1) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic.

TYPE LOCATION: Judith Basin County, Montana; 1,400 feet west and 600 feet south of the E 1/4 corner of Section 22, T. 19N, R. 9E.

NESTLEY SERIES

The Nestley series consists of very deep, moderately well-drained soils that formed in recent alluvium. These soils are on flood plains and low stream terraces. Slopes are 0 to 2 percent. Mean annual precipitation is about 12 inches. Mean annual air temperature is about 42° F.

TAXONOMIC CLASS: Sandy-skeletal, mixed Fluventic Haploborolls

TYPICAL PEDON: Nestley silt loam, irrigated pasture (colors are for dry soil unless otherwise noted).

A1 -- 0 to 1 inch; very dark grayish brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, very friable, slightly sticky and plastic; many very fine and fine and few medium roots; many very fine and fine pores; mildly alkaline (pH 7.6); clear wavy boundary.

A2 -- 1 to 11 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and plastic; many very fine and few fine roots; many very fine and few fine pores; mildly alkaline (pH 7.8); clear wavy boundary. (combined thickness of A horizons is 7 to 15 inches)

BC -- 11 to 16 inches; brown (10YR 5/3) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine pores; 5 percent pebbles; mildly alkaline (pH 7.8); abrupt smooth boundary. (2 to 10 inches thick)

2C -- 16 to 60 inches; light brownish gray (10YR 6/2) very gravelly sand, grayish brown (10YR 5/2) moist; single grain; loose; nonsticky and nonplastic; few very fine roots in the top 12 inches; 50 percent pebbles; mildly alkaline (pH 7.4).

TYPE LOCATION: Jefferson County, Montana; 700 feet south and 2,100 feet east of the NW corner of Section 2, T. 1N, R. 3W.

SILAS SERIES

The Silas series consists of very deep, moderately well-drained soils that formed in mixed alluvium. Silas soils are on mountain valley fills and have slopes of 0 to 12 percent. Mean annual precipitation is about 15 inches. Mean annual temperature is about 35° F.

TAXONOMIC CLASS: Fine-loamy, mixed Cumulic Cryoborolls

TYPICAL PEDON: Silas loam, rangeland (colors are for dry soil unless otherwise noted).

A1 -- 0 to 8 inches; very dark grayish brown (10YR 3/2) loam, black (10YR 2/1) moist; weak very fine crumb structure; soft, very friable, slightly sticky and nonplastic; many very fine medium and coarse roots; few pebbles and cobbles; slightly acid (pH 6.1); abrupt smooth boundary. Can range from 1 to 10 inches thick.

A2 -- 8 to 33 inches; dark grayish brown (10YR 4/2) loam, black (10YR 2/1) moist; massive; soft, very friable, slightly sticky and nonplastic; many very fine and medium coarse roots; few pebbles and cobbles; slightly acid (pH 6.4); abrupt wavy boundary. Can range from 10 to 20 inches thick.

C -- 33 to 60 inches; brown (10YR 5/3) loam stratified with thin lenses of very fine sandy loam, silt loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; 10 percent gravel, 5 percent cobbles; slightly acid (pH 6.4).

DESCRIPTION LOCATION: Jefferson County, Montana; 950 feet west and 1,900 feet south of the NE corner of Section 16, T. 6N, R. 3W.

NIEMAN SERIES

The Nieman series consists of shallow, well-drained soils that formed in residuum derived from fine grained sandstone and fine grained igneous bedrock. These soils are on hills and mountains. Slopes are 4 to 60 percent. Mean annual precipitation is about 17 inches. Mean annual temperature is about 38° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Argic Lithic Cryoborolls

TYPICAL PEDON: Nieman very cobbly loam, very stony, in rangeland (colors are for dry soil unless otherwise noted).

A -- 0 to 4 inches; brown (10YR 4/3) very cobbly loam, dark brown (10YR 3/3) moist; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine interstitial pores; 20 percent cobbles and 25 percent pebbles; neutral (pH 6.6); clear wavy boundary. Can range from 4 to 7 inches thick.

Bt1 -- 4 to 6 inches; dark grayish brown (10YR 4/2) very cobbly loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine interstitial pores; common faint brown (10YR 4/3) clay films on faces of peds; 30 percent cobbles and 25 percent pebbles; slightly acid (pH 6.4); clear wavy boundary.

Bt2 -- 6 to 12 inches; dark grayish brown (10YR 4/2) extremely cobbly loam, dark grayish brown (10YR 4/2) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and many fine roots; many very fine and fine interstitial pores; common distinct clay films on faces of peds; 50 percent cobbles and 20 percent pebbles; slightly acid (pH 6.4). Combined thickness of Bt horizons can range from 6 to 12 inches.

R -- 12+ inches; hard fine grained igneous bedrock.

DESCRIPTION LOCATION: Jefferson County, Montana; 350 feet south and 1,000 feet east of the NW corner of Section 5, T. 5N, R. 3W.

SIEBERELL SERIES

The Sieberell series consists of very deep, well-drained soils that formed in alluvium derived from mixed rock sources. These soils are on relict stream terraces, and alluvial fans. Slopes are 0 to 15 percent. Mean annual precipitation is about 12 inches, and mean annual air temperature is about 42°F.

TAXONOMIC CLASS: Loamy-skeletal over sandy or sandy-skeletal, mixed Aridic Argiborolls

TYPICAL PEDON: Sieberell very gravelly loam, in rangeland (colors are for dry soil unless otherwise noted).

A -- 0 to 6 inches; grayish brown (10YR 5/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; weak medium and fine subangular blocky structure; soft, very friable, sticky and slightly plastic; many very fine and few fine roots; many very fine and fine and few medium pores; 10 percent cobbles and 30 percent pebbles; neutral (pH 6.6); clear smooth boundary. (5 to 8 inches thick)

Bt -- 6 to 11 inches; light olive brown (2.5Y 5/4) very gravelly clay loam, olive brown (2.5Y 4/4) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine and few fine roots; many very fine and few fine tubular and interstitial pores; many distinct olive brown (2.5Y 4/4) clay films on faces of peds; 10 percent cobbles, 30 percent pebbles; neutral (pH 6.8); clear wavy boundary. (5 to 9 inches thick)

Bk -- 11 to 30 inches; pale yellow (2.5Y 7/4) extremely cobbly sandy clay loam, light yellowish brown (2.5Y 6/4) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; common very fine and few fine tubular and interstitial pores; 30 percent cobbles, 45 percent pebbles; disseminated lime, common faint lime coatings on tops and sides of fragments, common distinct lime casts on undersides of fragments; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary. (10 to 20 inches thick)

2C -- 30 to 60 inches; light yellowish brown (2.5Y 6/4) extremely cobbly loamy sand, light olive brown (2.5Y 5/4) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; 10 percent stones, 30 percent cobbles, 35 percent pebbles; common prominent lime casts on undersides of fragments; strongly effervescent; moderately alkaline (pH 8.0)

TYPE LOCATION: Jefferson County, Montana; 1,600 feet south and 100 feet east of the NW corner of Section 9, T. 4N., R. 3W.

PENSORE SERIES

The Pensore series consists of shallow, well-drained soils that formed in residuum derived from limestone. These soils are on bedrock-floored plains and mountains. Slopes are 2 to 75 percent. Mean annual precipitation is about 12 inches. Mean annual temperature is about 43° F.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic Borollic Lithic Calciorthids

TYPICAL PEDON: Pensore gravelly loam, in grassland (colors are for dry soil unless otherwise noted).

A -- 0 to 4 inches; grayish brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; 20 percent angular pebbles; disseminated lime; strongly effervescent; moderately alkaline (pH 8.0); clear smooth boundary. (3 to 7 inches thick)

Bk -- 4 to 15 inches; light gray (10YR 7/2) very gravelly loam, pale brown (10YR 6/3) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular and interstitial pores; 45 percent angular pebbles, 15 percent angular cobbles; disseminated lime; continuous faint lime coating on top of coarse fragments; continuous prominent lime casts on undersides of coarse fragments; violently effervescent; moderately alkaline (pH 8.2); gradual wavy boundary (7 to 15 inches thick)

R -- 15 inches; hard limestone bedrock with a few fractures; few very fine roots in fractures.

TYPE LOCATION: Lewis and Clark County, Montana; 500 feet east and 400 feet south of the NW corner of Section 30, T. 10N, R. 4W.

SIEBEN SERIES (Continued)

Bk2 -- 30 to 41 inches; very pale brown (10YR 7/3) extremely gravelly loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; 55 percent angular pebbles and 20 percent angular cobbles; continuous lime prominent on fragments; lime cemented sand and fine gravel on undersides of some fragments; violently effervescent; moderately alkaline (pH 8.0); gradual smooth boundary. (8 to 15 inches thick)

Bk3 -- 41 to 60 inches; pale brown (10YR 6/3) extremely gravelly sandy loam, dark brown (10YR 4/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; 60 percent angular pebbles and 15 percent angular cobbles; continuous faint lime casts on underside of fragments; strongly effervescent; moderately alkaline (pH 8.0).

TYPE LOCATION: Lewis and Clark County, Montana; 1,900 feet south and 50 feet east of the NW corner of Section 15, T. 13N, R. 4W.

REDFERN SERIES

The Redfern series consists of shallow, well-drained soils that formed in colluvium or residuum derived from hard fine grained sandstone or fine grained igneous rock. These soils are on mountains. Slopes are 8 to 60 percent. Mean annual precipitation is about 17 inches. Mean annual temperature is about 38° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Lithic Cryoboralfs

TYPICAL PEDON: Redfern very cobbly loam, bouldery, forested (colors are for dry soil unless otherwise noted).

Oi -- 1/2 to 0 inches; partially decomposed needles, twigs and leaves. Can range from 0 to 3 inches thick.

A -- 0 to 3 inches; light brownish gray (2.5Y 6/2) very cobbly loam, dark grayish brown (2.5Y 4/2) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; many very fine and fine interstitial and tubular pores; 20 percent cobbles, 30 percent pebbles; slightly acid (pH 6.1); clear smooth boundary. Can range from 0 to 5 inches thick.

E -- 3 to 7 inches; light gray (10YR 7/2) extremely gravelly loam, brown (10YR 5/3) moist; weak fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; many very fine and fine interstitial and tubular pores; 15 percent cobbles, 50 percent pebbles; moderately acid (pH 6.0); clear smooth boundary. Can range from 3 to 8 inches thick.

Bt -- 7 to 13 inches; yellowish brown (10YR 5/4) extremely gravelly clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; common very fine and fine and few medium roots; common very fine and fine interstitial and tubular pores; many distinct dark grayish brown (10YR 4/2) clay films on faces of peds and bridging sand grains; 20 percent cobbles, 45 percent pebbles; 10 percent cobbles; slightly acid (pH 6.2). Can range from 6 to 13 inches thick.

R -- 13+ inches; hard fine grained igneous bedrock.

DESCRIPTION LOCATION: Jefferson County, Montana; 1,200 feet south and 900 feet east of the NW corner of Section 9, T. 5N, R. 3W.

SIEBEN SERIES

The Sieben series consists of very deep, well-drained soils that formed in gravelly alluvium and colluvium derived from argillite and igneous rock. These soils are on dissected alluvial fans, stream terraces, and mountains. Slopes are 2 to 45 percent. Mean annual precipitation is about 12 inches. Mean annual temperature is about 43° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Aridic Argiborolls

TYPICAL PEDON: Sieben gravelly loam, rangeland (colors are for dry soil unless otherwise noted).

A1 -- 0 to 5 inches; grayish brown (10YR 5/2) gravelly loam, very grayish brown (10YR 3/2) moist; moderate very thin platy structure parting to moderate very fine granular; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; 20 percent angular pebbles; slightly acid (pH 6.2); clear smooth boundary. (3 to 6 inches thick)

A2 -- 5 to 9 inches; grayish brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular and interstitial pores; 20 percent angular pebbles; slightly acid (pH 6.2); clear smooth boundary. (3 to 6 inches thick)

Bt1 -- 9 to 17 inches; pale brown (10YR 6/3) very gravelly clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, sticky and plastic; common very fine roots; many very fine tubular and interstitial pores; many distinct brown (10YR 5/3) clay films on faces of peds; 45 percent angular pebbles; slightly acid (pH 6.4); gradual smooth boundary. (6 to 15 inches thick)

Bt2 -- 17 to 21 inches; pale brown (10YR 6/3) very gravelly loam, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; slightly hard, very friable, sticky and slightly plastic; common very fine roots; many very fine tubular and interstitial pores; few faint clay films on faces of peds and on coarse fragments; 55 percent angular pebbles and 5 percent angular cobbles; few faint lime casts on undersides of coarse fragments; mildly alkaline (pH 7.8); gradual smooth boundary. (3 to 6 inches thick)

Bk1 -- 21 to 30 inches; very pale brown (10YR 7/3) very gravelly loam, pale brown (10YR 6/3) moist; weak medium and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular and interstitial pores; 45 percent angular pebbles and 10 percent angular cobbles; continuous distinct lime casts on underside of fragments; many fine seams and masses of lime; violently effervescent; moderately alkaline (pH 8.0); gradual smooth boundary. (5 to 15 inches thick)

REDFERN (2) SERIES

The Redfern (2) series consists of shallow, well-drained soils that formed in colluvium or residuum derived from hard fine grained sandstone or fine grained igneous rock. These soils are on mountains. Slopes are 8 to 60 percent. Mean annual precipitation is about 17 inches. Mean annual temperature is about 38° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Lithic Cryoboralfs

TYPICAL PEDON: Redfern very cobbly loam, bouldery, forested (colors are for dry soil unless otherwise noted).

Oi -- 1/2 to 0 inches; partially decomposed needles, twigs and leaves. Can range from 0 to 3 inches thick.

A -- 0 to 4 inches; very dark grayish brown (10YR 3/2) very cobbly loam, black (10YR 2/1) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; many very fine and fine interstitial and tubular pores; 20 percent cobbles, 30 percent pebbles; moderately acid (pH 5.8); clear smooth boundary. Can range from 0 to 5 inches thick.

E -- 4 to 9 inches; dark grayish brown (10YR 4/2) extremely gravelly loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; many very fine and fine interstitial and tubular pores; 15 percent cobbles, 50 percent pebbles; moderately acid (pH 5.8); clear smooth boundary. Can range from 3 to 8 inches thick.

Bt -- 9 to 14 inches; brown (10YR 5/3) extremely gravelly clay loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; common very fine and fine and few medium roots; common very fine and fine interstitial and tubular pores; many distinct dark grayish brown (10YR 4/2) clay films on faces of peds and bridging sand grains; 20 percent cobbles, 45 percent pebbles; 10 percent cobbles; moderately acid (pH 6.0). Can range from 6 to 13 inches thick.

R -- 14+ inches; hard fine grained skarn bedrock.

DESCRIPTION LOCATION: Jefferson County, Montana; 550 feet east and 50 feet south of the NW corner of Section 14, T. 6N, R. 3W.

SHOOK SERIES

The Shook series consists of moderately deep soils that developed in weathered intrusive granite in situ or only slightly reworked downslope. These soils are on granitic slopes. Slopes are 0 to 25 percent. Mean annual precipitation is about 17 inches. Mean annual temperature is about 38° F.

TAXONOMIC CLASS: Coarse-loamy, mixed Pachic Cryoborolls

TYPICAL PEDON: Shook coarse sandy loam (colors are for dry soil unless otherwise noted).

A1 -- 0 to 8 inches; very dark grayish brown (10YR 3/2) coarse sandy loam, black (10YR 2/1) moist; coarse and medium granular structure; slightly hard, very friable; (pH 6.4); clear smooth boundary. (6 to 12 inches thick)

B2 -- 8 to 16 inches; brown (10YR 4/3) coarse sandy loam, dark brown (10YR 3/3) moist; weak to moderate medium and coarse blocky structure; little or no more clay than in the horizon above; hard, friable, slightly sticky; (pH 6.6); gradual smooth boundary. (6 to 9 inches thick)

B2 -- 8 to 16 inches; brown (10YR 4/3) coarse sandy loam, dark brown (10YR 3/3) moist; weak to moderate medium and coarse blocky structure; little or no more clay than in the horizon above; hard, friable, slightly sticky; (pH 6.6); gradual smooth boundary. (6 to 9 inches thick)

B3 -- 16 to 28 inches; brown (10YR 4/3) coarse sandy loam (a shade lighter than the horizon above), dark brown (10YR 3/3) moist; weak coarse subangular blocky structure; abundant subangular granite fragments of fine gravel size; slightly hard, friable, slightly sticky; (pH 6.8); gradual smooth boundary. (10 to 14 inches thick)

C -- 28 to 36 inches; brown (10YR 5/3) very gravelly coarse sandy loam containing 50 percent or more granitic fragments of fine gravel size, brown (10YR 4/3) moist; loose; (pH 6.6); partly weathered granite below.

TYPE LOCATION: Ravalli County, Montana;

SAWBUCK SERIES

The Sawbuck series consists of deep and very deep, well-drained soils that formed in colluvium derived from igneous, argillite, metamorphic, and sedimentary rock. These soils are on mountains. Slopes are 15 to 60 percent. Mean annual precipitation is about 18 inches. Mean annual temperature is about 41° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Typic Argiborolls

TYPICAL PEDON: Sawbuck loam, forested (colors are for dry soil unless otherwise noted).

Oi -- 1 inch to 0; forest litter of partially decomposed twigs and needles.

A1 -- 0 to 6 inches; gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; moderate fine and very fine granular structure; soft, very friable, slightly sticky and slightly plastic; many fine and very fine roots, few medium and coarse roots; 5 percent angular pebbles; slightly acid (pH 6.2); gradual smooth boundary.

A2 -- 6 to 9 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; soft, very friable, slightly sticky and slightly plastic; many fine and very fine roots, few medium and coarse roots; many faint gray silt and sand skeletons on faces of peds; 5 percent angular pebbles; medium acid (pH 5.6); gradual smooth boundary. (The combined A horizons are 5 to 9 inches thick).

Bt1 -- 9 to 15 inches; brown (10YR 5/3) gravelly clay loam, dark brown (10YR 3/3) moist; moderate medium and fine subangular blocky structure; hard, friable, sticky and plastic; common fine and very fine roots, few medium roots; many very fine tubular and interstitial pores; common distinct dark brown (10YR 3/3) moist clay films on faces of peds; many faint gray silt and sand skeletons on faces of peds; 25 percent angular pebbles; medium acid (pH 5.6); clear smooth boundary. (2 to 8 inches thick)

Bt2 -- 15 to 40 inches; brown (10YR 5/3) very gravelly clay loam, dark grayish brown (10YR 4/3) moist; strong medium and fine subangular blocky structure; hard, friable, sticky and plastic; common fine and very fine tubular and interstitial pores; many distinct dark brown (10YR 3/3) moist clay films on faces of peds and lining pores; 45 percent angular pebbles and 5 percent angular cobbles; medium acid (pH 5.6); gradual smooth boundary. (20 to 30 inches thick)

SHAWMUT SERIES (Continued)

Bk2 -- 30 to 60 inches; grayish brown (2.5Y 5/2) extremely gravelly loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; many distinct lime coats on underside of pebbles; strongly effervescent; mildly alkaline (pH 7.7).

DESCRIPTION LOCATION: Jefferson County, Montana; about 1,800 feet south and 1,500 feet west of the NE corner of Section 4, T. 5N, R. 3W.

SAWBUCK SERIES (Continued)

Bt3 -- 40 to 48 inches; light gray (2.5Y 7/2) very gravelly silty clay loam, grayish brown (2.5Y 5/2) moist; moderate medium and fine subangular blocky structure; hard, friable, sticky and slightly plastic; common fine and very fine roots, few medium roots; many very fine tubular and interstitial pores; many distinct clay films on faces of peds; many faint silt and sand skeletons on faces of peds; common distinct pale yellow (2.5Y 7/4) stains on faces of peds and on coarse fragments; 40 percent angular pebbles; medium acid (pH 6.0); gradual smooth boundary. (5 to 10 inches thick)

Bt4 -- 48 to 60 inches; light brownish gray (2.5Y 6/2) gravelly silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium and fine subangular blocky structure; hard, friable, sticky and slightly plastic; few very fine roots; many very fine tubular and interstitial pores; common distinct clay films on faces of peds; common distinct pale yellow (2.5Y 7/4) stains on peds and coarse fragments; 15 percent pebble size angular sandstone and shale fragments; medium acid (pH 5.9).

TYPE LOCATION: Lewis & Clark County, Montana; 1,400 feet north and 1,300 feet east of the SW corner of Section 4, T. 14N, R. 2W.

SHAWMUT SERIES

The Shawmut series consists of very deep, well-drained soils that formed in gravelly alluvium or colluvium. These soils are on alluvial fans, stream terraces, hills, and mountains. Slopes are 0 to 60 percent. Mean annual precipitation is about 16 inches. Mean annual temperature is about 46° F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Typic Argiborolls

TYPICAL PEDON: Shawmut gravelly loam, in grassland (colors are for dry soil unless otherwise noted).

A -- 0 to 3 inches; brown (10YR 4/3) gravelly loam, dark brown (10YR 3/3) moist; moderate fine granular structure; weak, thin platy in upper inch; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; about 15 percent pebbles and 5 percent cobbles; neutral (pH 6.9); clear wavy boundary. Can range from 3 to 6 inches thick.

Bt1 -- 3 to 7 inches; dark grayish brown (10YR 4/2) gravelly clay loam, very dark grayish brown (10YR 3/2) moist; weak fine prismatic structure parting to strong fine angular and subangular blocky; hard, very friable, sticky and plastic; many fine roots; common fine pores; common faint clay films on faces of peds and on pebbles; 35 percent pebbles, 5 percent cobbles; neutral (pH 6.8); clear boundary.

Bt2 -- 7 to 12 inches; dark grayish brown (10YR 4/2) gravelly clay loam, very dark grayish brown (10YR 3/2) moist; strong fine blocky structure; hard, very friable, sticky and plastic; many fine and very fine roots; common fine pores; many distinct clay films on faces of peds and on pebbles; 35 percent pebbles, 5 percent cobbles; neutral (pH 6.7); clear wavy boundary. Combined thickness of Bt horizons can range from 6 to 14 inches thick.

Btk -- 12 to 15 inches; grayish brown (10YR 5/2) very gravelly clay loam, dark grayish brown (10YR 4/2) moist; moderate medium and fine blocky structure; hard, very friable, sticky and plastic; many fine roots; common fine pores; common faint clay films on faces of peds; 50 percent pebbles, 5 percent cobbles; common distinct lime coats on underside of coarse fragments; strongly effervescent; mildly alkaline (pH 7.6); clear wavy boundary. Can range from 3 to 6 inches thick.

Bk1 -- 15 to 30 inches; grayish brown (2.5Y 5/2) very gravelly loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; 50 percent pebbles, 5 percent cobbles; many distinct lime coats on underside of coarse fragments; strongly effervescent; mildly alkaline (pH 7.6); gradual smooth boundary. Can range from 8 to 15 inches thick.